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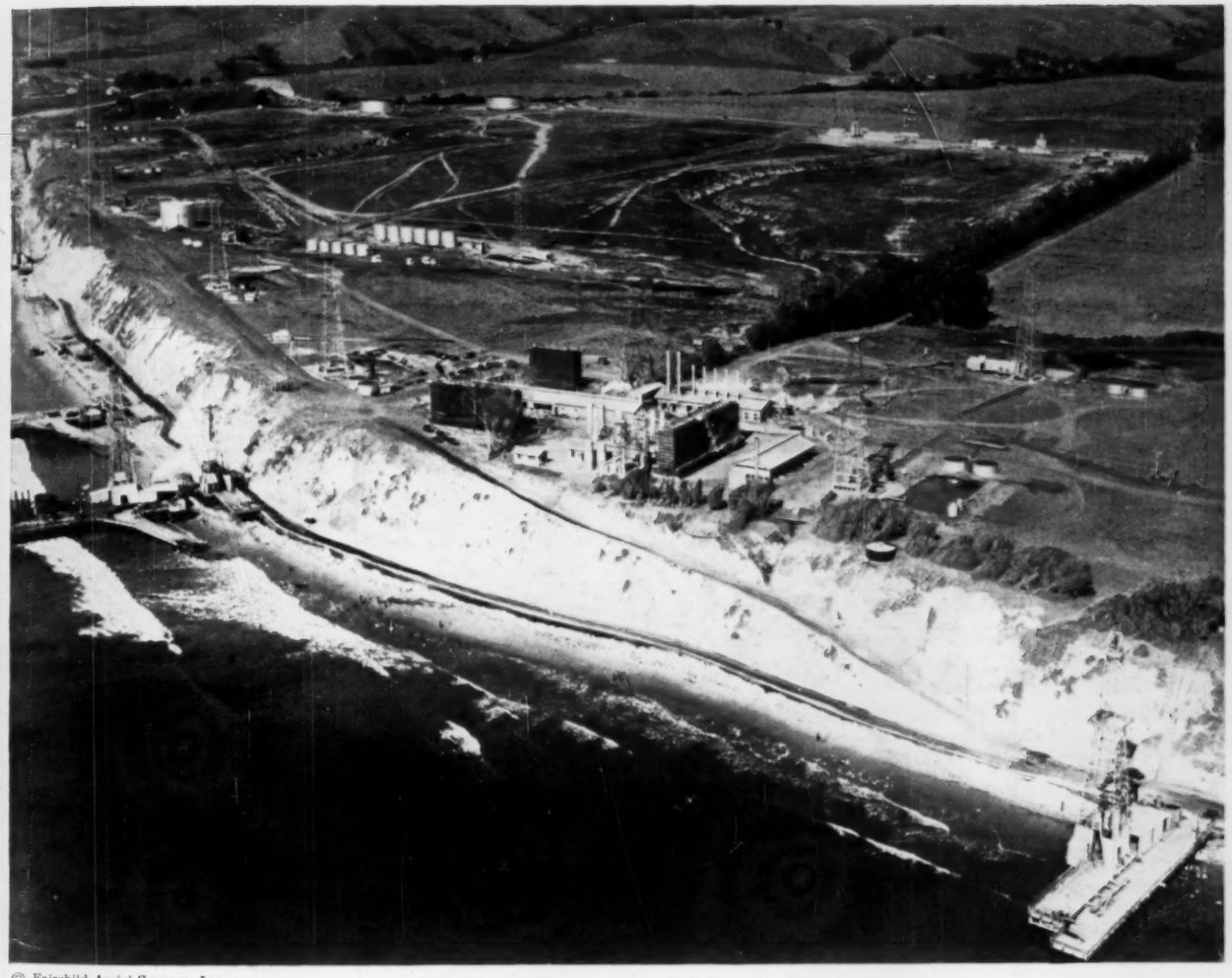

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OIL FIELDS EXTEND UNDER PACIFIC OCEAN—GOLETA, CALIF.

Volume 1 — Number 8

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

MAY 1931

"On the job" *for* The H. K. Ferguson Co., at Asheville, N. C.

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American Enka Corporation
Building Site

Below:
Completed Plant of the
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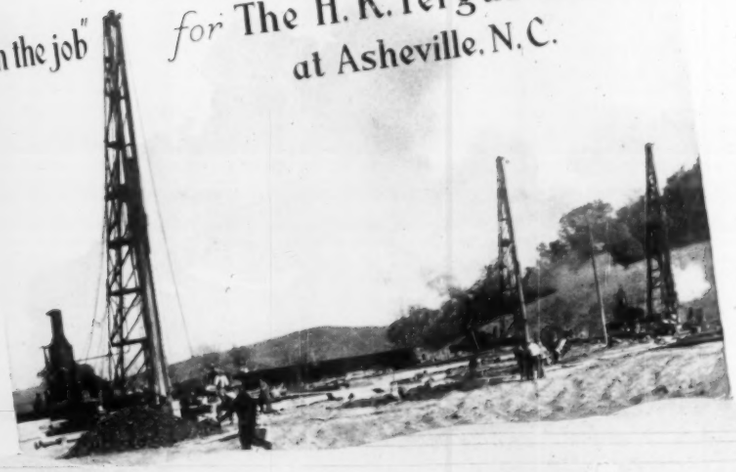
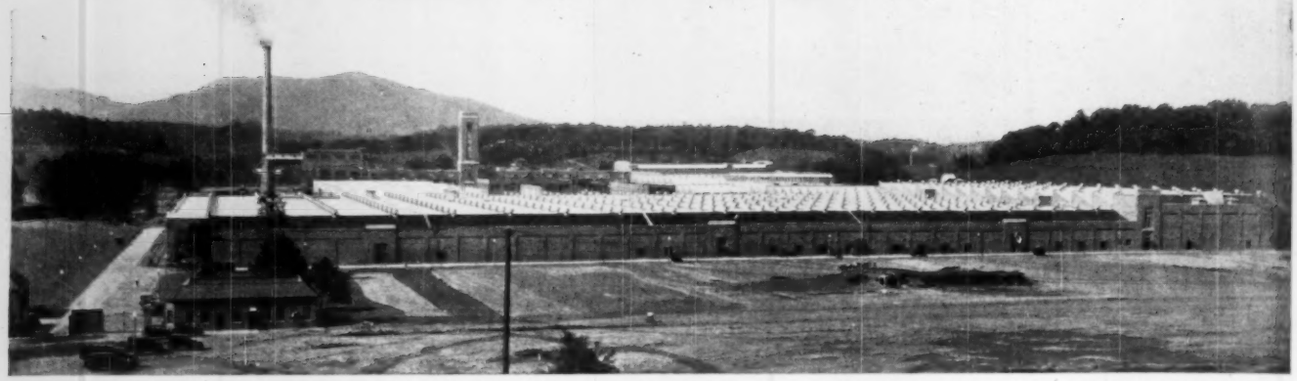
Asheville, N. C.
The H. K. Ferguson Co.
Engineers and
General Contractors





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In his effort to discover greater usefulness for water, the engineer has devised elaborate models. A series of articles in this issue details progress in hydraulic testing methods both here and abroad.

PIERS FOR PASSAIC RIVER CROSSING—LINCOLN HIGHWAY KEARNEY, N. J.

TOPS OF RIVER PIERS ABOVE WATER LEVEL—94 FEET
CLEARANCE OF BRIDGE ABOVE WATER LEVEL—135 FEET
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Among Our Writers

J. L. Savage is considered an authority on the design of dams and other hydraulic structures. He has, for over a quarter of a century, been continuously at work on Western irrigation and power projects. As a government expert, he recently made a trip to Panama in connection with the construction of the proposed Madden Dam.

Ivan E. Houk, upon graduation from the State University of Iowa in 1911, became affiliated with the work of the Miami Conservancy District, where he was in charge of stream gaging, flood forecasting, and experiments on the flow of water in open channels. He is the author of numerous technical reports on that work. In 1924 he entered the service of the U.S. Bureau of Reclamation.

R. F. Ewald, a 1905 graduate of the University of Wisconsin, taught Hydraulics at his alma mater. Later, while with the U.S. Bureau of Reclamation, he worked on the Lower Yellowstone Project and had charge of the design of tunnels and storage reservoirs for the control of Lake Utah. He is, at present, with the Aluminum Company of America.

Hunter Rouse in 1929 received the Massachusetts Institute of Technology's two-year Traveling Scholarship in Hydraulics as a prize for the excellence of his work in that institution. This fellowship has included study in European hydraulic laboratories at Karlsruhe and Obernach. During the coming summer Mr. Rouse will visit various laboratories in England, returning to Cambridge in October to teach.

H. F. Gonnerman began his engineering career over twenty years ago at the University of Illinois, where he served as instructor in theoretical and applied mechanics and conducted tests of reinforced concrete and concrete materials. In 1922 he went to the Lewis Institute Structural Materials Research Laboratory, Chicago, and in 1926 affiliated also with the Research Laboratory of the Portland Cement Association.

T. F. Davey, who was born in England and received his engineering education at the University of London, began work in this country in 1925 with the British and American Mercantile Company. He has designed the largest oil reservoir in the world and built foundations for California marine oil wells.

Maxwell Halsey, holder of the first Albert Russel Erskine Fellowship on Street Traffic Research in Harvard University, has been associated with Miller McClintock in traffic surveys in Los Angeles, Chicago, and Boston. He has also been Traffic Engineer for the Massachusetts State Department of Public Works.

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May 1931

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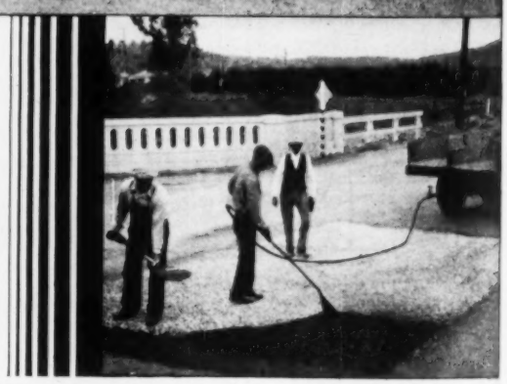

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VOLUME 1 MAY 1931 NUMBER 8

Checking Arch Dam Designs with Models

Results of Tests on Small-Scale Models of the Stevenson Creek and Gibson Arch Dams

By J. L. SAVAGE AND IVAN E. HOUK
MEMBERS AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF DESIGNING ENGINEER AND SENIOR ENGINEER, U.S. BUREAU OF RECLAMATION, DENVER

A REMARKABLE similarity has been found between measured deflections of the full-sized Stevenson Creek Test Dam and those calculated from the deflections of a 1:12-scale model tested with a mercury load. Data taken on a 1:68-scale model of the Gibson Dam, under mercury load and with extreme temperature changes, checked closely with the results of an analysis of the model by the trial load method. If tests made on models can be relied upon to correctly reveal the conditions in their full-sized prototypes, and if mathematical calculations based on a properly conceived theory check these tests, a great step will have been made toward building safe and economical high arch dams.

DURING the summer of 1927, the Bureau of Reclamation, in cooperation with the Engineering Foundation's Committee on Arch Dam Investigation and the University of Colorado, began a comprehensive program of experimental work on small-scale models of arch dams. The purpose of the tests was to supply definite information regarding the safety of arch dams already built or now being constructed by the Bureau of Reclamation; to check the trial load method of designing arch dams as developed and used by the bureau during the past six years; to demonstrate the feasibility or infeasibility of using small-scale model tests in planning costly arch dam structures; and to provide the complicated technical data needed for comprehensive engineering studies of deformations and stress distribution in arch dams, particularly in the 727-ft. Hoover Dam on the Colorado River near Las Vegas, Nev., the contract for which has just been awarded.

Thus far, the results obtained have been very satisfactory. Although they have by no means solved all the complicated problems involved in arch dam design, they have established the accuracy of the trial load method of analysis and have made possible a more exact, and consequently a more economic design of arch dam structures.

EXPERIMENTAL PIT OF REINFORCED CONCRETE

As the first step in this comprehensive program of tests, an experimental pit was built, in June 1927, beneath the floor of the Testing Materials Laboratory of the University of Colorado, Boulder, using local aggregates and a mix of approximately 1:2:4 proportions. In Fig. 1 is shown the plan and a section of the pit, which has a depth of 5 ft., a maximum inside length of 18 ft., and a maximum inside width of 12 ft. The octagonal, stepped design permits the testing of models of practically any shape, symmetrical or unsymmetrical, and of practically any size not exceeding the maximum inside dimensions of the pit.

For any particular test, the shape of the pit is altered to that of the dam site under consideration by building up a supplemental base of concrete, or of the material to be used in the model. In order to secure the greatest similarity between the model and the full-sized dam, it is desirable to have the ratio of the moduli of elasticity of the model and the supplemental base the same as that of the concrete and abutment rock of the full-sized structure.

So that it would be possible to tie the walls of the pit together in case of undesirably large abutment deformations, 25-lb. rails, bent in the shape of a U, were included as vertical reinforcement along the longitudinal center line of the pit and at locations $2^1/_2$ ft. on each side of the transverse center line. The ends of the rail were allowed to project 6 in. above the tops of the walls.

On January 11, 1928, the supplemental base was poured for the model of the Stevenson Creek Test Dam, the 60-ft. concrete arch built by the Engineering Foundation's Committee on Arch Dam Investigation at Big Creek, Calif. In pouring the base, local aggregates and cement were used, mixed by volume in the proportions of approximately 1:2:3. Before pouring the model the top of the base was roughened by chipping out a groove along the location of the contact surface. For the model,

UPSTREAM FACE OF MODEL OF STEVENSON CREEK TEST DAM
The Horizontal Line Is a Steel-Form Joint Mark

which was poured on March 22, 1928, fine aggregate shipped from the Stevenson Creek Test Dam was mixed with local cement in the proportions of 1:3.25, by weight.

No coarse aggregate was used because of the comparatively thin section of the upper half of the model, which was uniform from abutment to abutment at all elevations, and only 2 in. in amount. The water-cement ratio was 1.0, and the average slump 9.1 in. A fairly wet mix was necessary so that the concrete would flow through the tremie to the bottom of the forms and fill all spaces around the small deflection anchors at the downstream face, where no spading was possible.

A plan of the model, the developed downstream elevation, and the maximum cross section are shown in Fig. 2. Invar bars for measuring abutment movements were placed at elevations corresponding to those at which similar measurements had been made for the full-sized dam. Likewise, deflection anchors for attaching dials to measure the radial deflections were located at vertical and horizontal sections corresponding to those investigated at the dam.

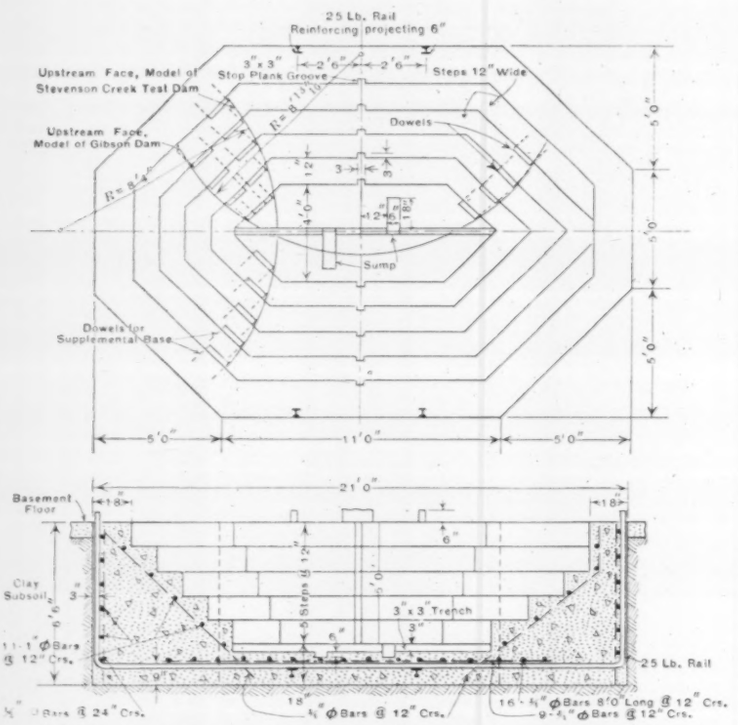


FIG. 1. EXPERIMENTAL PIT FOR MODEL TESTS OF ARCH DAMS
University of Colorado Testing Laboratory, Boulder

WORK OF TESTING

This model of the Stevenson Creek Test Dam was tested under concentrated radial loads applied at the center line; under a triangular water load; under a triangular mercury load; and, finally, under a water pressure which was gradually increased until failure occurred. Water and mercury loads were applied in a rubber bag in all cases (Fig. 2), and tests were made for partial depths of load as well as for full depths in the case of the triangular loads. Since mercury is 13.6 times as heavy as water, the application of the triangular, full-depth, mercury load to the 1:12-scale model was a slightly more severe test than the application of the full reservoir water load to the full-sized dam.

In the test to destruction, failure of the upper 25 in. of the model, above a horizontal crack which had developed during the mercury-load tests, occurred under a water pressure of 25 lb. per sq. in., which is equivalent to that caused by a head of 59 ft. of water. The lower part of the model did not fail at all. The total pressure on the upper part at the time of failure amounted to approximately 37 tons, or about 5.3 times as much load as was carried during the full-depth mercury test. Failure occurred by the sliding of the upper portion of the model up one abutment.

The water-load tests were made before the mercury tests and before any cracking occurred, except for some minor cracks at the lines of contact between the model and the abutments, which developed during the curing period when the model was not being sprinkled. As soon as the abutment cracks were noticed, sprinkling was begun and was continued throughout the testing work. Since the full-sized dam was cracked, and since the mercury load produced cracks in the model very similar to those in the dam, the results of the water-load tests, although furnishing much valuable data, did not check the measurements at the dam as well as the mercury-load tests.

Observations made during the mercury-load tests included measurements of radial deflections, changes in chord lengths, spreading of abutments, the opening of a crack at the upstream edge of the base of the crown section, changes in mid-ordinates, and horizontal, vertical, and diagonal strains at the downstream face. Changes in mid-ordinates and strains at the downstream face were measured with an optical strain gage. Other deformations and radial deflections were measured with 0.0001 dials.

A comparison between the measured, radial deflections at the full-sized dam and those indicated by the full-depth mercury tests on the model is given in Fig. 3. It will be noticed that the two curves are in very close agreement in all parts of the structure. A slight difference in deflections occurs at the quarter points, but the deflections at the crown section are almost in exact agreement at all elevations.

Deflections were calculated and compared using the formula:

$$\text{Deflection of dam} = \frac{Em}{\delta n^2 E_d} \times \text{deflection of model}$$
$$= 8.588 \text{ deflection of model,}$$

where

Em = modulus of elasticity of model = 2,920,000 lb. per sq. in.
E_d = modulus of elasticity of dam = 3,600,000 lb. per sq. in.
δ = density of mercury = 13.6
n = scale of model = 1/12

A model was also constructed of Gibson Dam, the 200-ft. concrete arch completed in 1928 on the Sun River Project of the Bureau of Reclamation, in Montana. The supplemental base was poured February 13, 1929, using local materials mixed in the proportions of $1:2^1/_2:2^1/_2$. That part of the top surface which would later be in direct contact with the base of the model was stepped so as to obtain a bond which would prevent sliding such as caused the failure of the model of the Stevenson Creek Test Dam.

POURING THE MODEL OF GIBSON DAM

On March 5, 1929, the model was poured, using a concrete mix of $1:2^1/_2:2$, by weight; a water–cement ratio of 1.0; and an average slump of 6.5 in., a fairly wet mix being necessary in order to get the concrete around the small deflection anchors near the bottom of the model where no spading was possible. The cement, sand, and gravel for building the model were shipped from the dam. The sand was 50 per cent natural and 50 per cent manufactured, thoroughly mixed, and the aggregate was pea gravel which would pass a $^3/_8$-in. sieve. No coarser material could be used because of the comparatively small dimensions of the model. Seven batches of concrete were required, but since the pouring was continuous there were no construction joints in the finished structure, either horizontal or vertical. The model was sprinkled continuously during the curing process and also during the tests.

An illustration shows the model soon after the tests were begun, the rubber bag and steel plate being moved back so as to expose the upstream face. The white patches at the downstream face are places where the concrete happened to be dry at the time the photograph was taken. Dials for measuring radial deflections, and invar bars and dials for recording the spreading of the abutments and changes in chord lengths can be seen at the downstream side. In Fig. 4 is shown a crown cross section, and details of the mercury supply tank and piping.

For the full-depth mercury test the maximum radial deflection was only 0.0015 in., or only 15 divisions on the measuring dial; while the maximum strain at the downstream face was only 14 millionths in. per in. Nevertheless, very satisfactory data were secured, and the results were found to check very closely with those calculated in the analysis of the model by the trial load method.

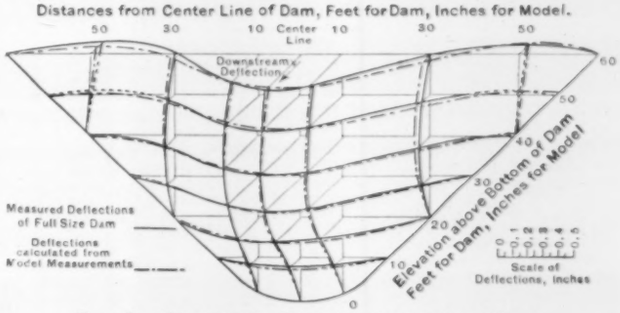


FIG. 3. STEVENSON TEST DAM AND ITS MODEL
Deflections Compared Under Full-Depth Loads

In Fig. 5 is shown a comparison of the stresses measured at the downstream face of the model with those calculated by the trial load method, assuming a straight line distribution of stress and making proper allowances for radial movements, tangential sheer, and the effects of twist and Poisson's ratio. It will be noticed that the calculated stresses are in very satisfactory agreement with the measured stresses at all elevations, in both arch and cantilever elements. Such differences as do exist would be practically eliminated if corrections were made for the non-rectilinear distribution of stress.

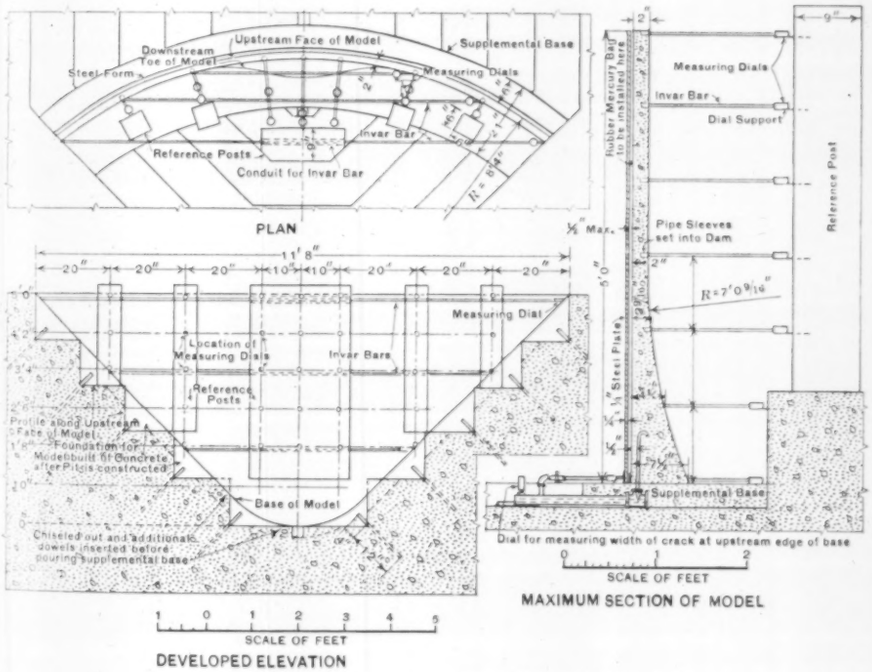


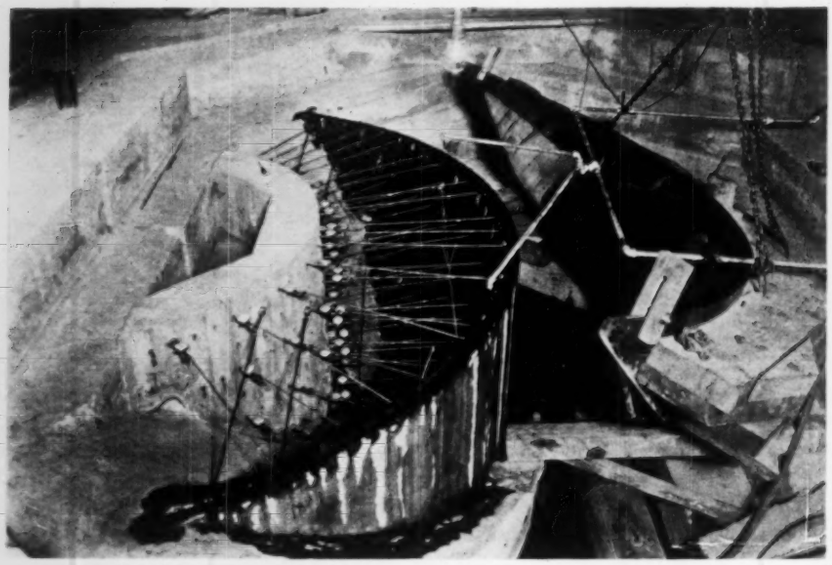
FIG. 2. MODEL OF THE STEVENSON CREEK TEST DAM
Scale of Model 1:12

TEMPERATURE TESTS OF GIBSON MODEL

After the mercury-load tests were completed, the model of Gibson Dam was subjected to an elaborate and extremely severe temperature test, changes being produced by means of a sprinkling system at the top of the model, through which hot, temperate, or cold water could be supplied as desired. A separate sprinkling system at the ends of the model, supplied with hydrant water, kept the abutments and foundation at a comparatively uniform temperature, regardless of the temperatures within the model.

A total of 59 thermometers, inserted at different depths in the model and in the abutment concrete were used. Radial deflections were measured with 0.0001 dials,

as in the mercury load tests, but owing to the nature of the tests it was not feasible to make direct measurements of strains. The total range in the average temperature of the model obtained during the tests was about 27 deg.



MODEL OF GIBSON DAM—RUBBER BAG AND STEEL PLATE MOVED BACK
Deflection Dials in Place at Downstream Face

cent., from a minimum value of about 8 deg. cent. to a maximum of about 35 deg.

The purpose of the temperature test was to secure an additional, independent check on the trial load method of analyzing arch dams. It was realized that the total range in concrete temperatures obtained in such a test would be much greater than the maximum seasonal changes in a dam as large as Gibson. However, it was believed that an extreme test would furnish a better check on the complicated mathematical processes involved in the trial load analysis than would one more nearly representative of field conditions.

The trial load analysis of the model for the temperature test included the restraining effect of the cantilever elements, the effects of tangential sheer and of twist, and was made for the conditions existing at the time of maximum temperature drop. A comparison of the calculated and observed radial deflections for one of the horizontal elements is given in Fig. 6. Calculated curves are shown for the different steps involved in the analysis, so that the effects of the various restraining actions can be visualized.

These curves show that the final calculated deflections are very nearly the same as the observed deflections. What little discrepancy still exists would be nearly eliminated by making proper allowances for the modifying effects of Poisson's ratio. One of the principal things indicated is the very marked effect of the restraining action of the cantilevers. This effect is represented by the difference between the curves marked "deflection of free arch" and those marked "first radial adjustment."

MATERIALS FOR BUILDING MODELS INVESTIGATED

Very complete laboratory tests of the concrete used in the models of Gibson and of Stevenson Creek Test Dam were made, primarily to determine the values of the elastic properties involved in the analyses of the models. Probably two of the most unusual features connected with the concrete tests were the measurements of flow in flexure and ultimate strength in torsion.

Tests on the model of Gibson Dam, although furnishing satisfactory data under the full-depth mercury load, showed conclusively that for larger dams it would be advisable to build models out of materials having definitely lower moduli of elasticity than concrete. This is especially true for the Hoover Dam, the design for which it is desired to check by model tests.

After an exhaustive investigation, it has been concluded that the most suitable materials for building small models of large dams are celluloid, or a mixture of plaster of paris and celite. The plaster of paris and celite mixtures necessary to obtain moduli of elasticity less than 250,000 lb. per sq. in. have comparatively low unit weights. Some of the mixtures tested had unit

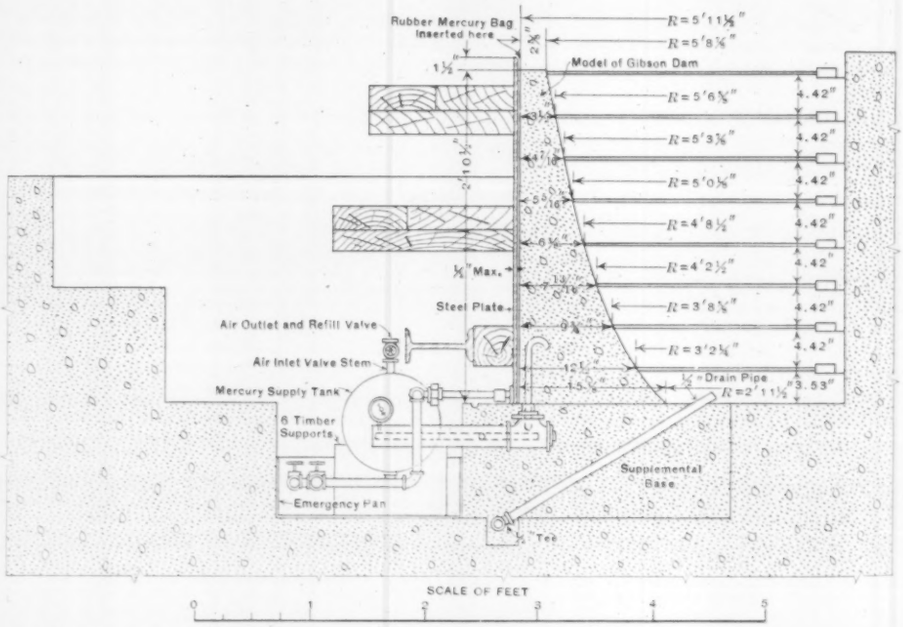


FIG. 4. MODEL OF GIBSON DAM
Arrangement of Test, Scale 1:68

weights as low as 30 lb. per cu. ft. However, it was found entirely feasible to increase these to approximately that of concrete by simply adding proper proportions of small shot to the mixture. Although the presence of the shot seemed to increase the modulus of elasticity slightly, it was still possible to obtain practically any modulus desired by using the proper proportions of plaster and celite. The use of shot will probably be found advisable in cases where it is desired to duplicate as closely as possible the action of the cantilever elements.

MODELS OF HOOVER DAM

At the present time the Bureau of Reclamation is building a plaster of paris and celite model of Hoover Dam, using proportions which will give a modulus of elasticity of from 125,000 to 150,000 lb. per sq. in. It was not considered necessary to use shot in the mixture in this case inasmuch as there is a very heavy vertical mercury load on the upstream face of the model. In fact, due to the upstream batter and the resulting vertical water load, no tension would occur at the base of the crown cantilever section of the full-sized Hoover Dam if the concrete had no weight at all.

At the base of its maximum cross section, this model will be $36^3/_8$ in. high and $32^1/_2$ in. thick. It is being built up in horizontal layers $2^1/_2$ in. thick, each joint being provided with keys to give satisfactory bond. The surface of each layer is waterproofed with shellac or varnish, so as to prevent the absorption of moisture from above when the next layer is poured.

It is also planned to manufacture and test a celluloid model of Hoover Dam, to be 29 in. high and 26 in. thick at the base of the crown section. This model will have a modulus of elasticity of approximately 260,000 lb. per sq. in. and will consequently require somewhat more refined measurements of deformations than are necessary in the case of the plaster of paris and celite model.

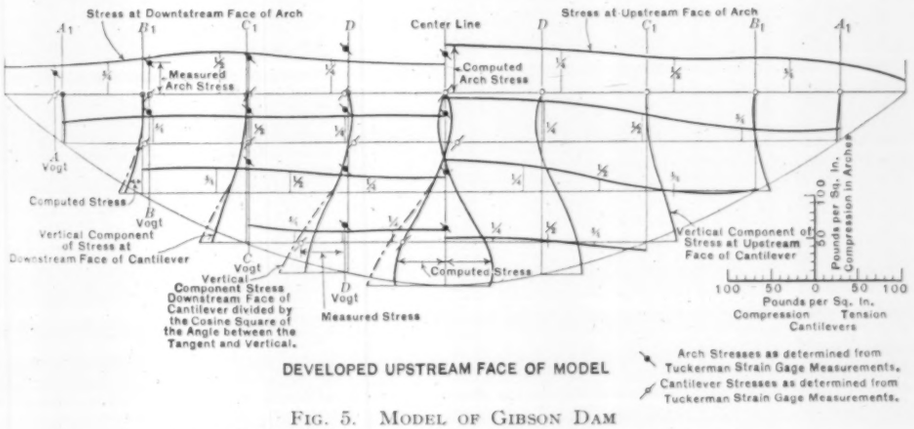

Stress at Downstream Face of Arch
Center Line
Stress at Upstream Face of Arch
Measured Arch Stress
Computed Arch Stress
Computed Stress
Vertical Component of Stress at Downstream Face of Cantilever
Vertical Component Stress Downstream Face of Cantilever divided by the Cosine Square of the Angle between the Tangent and Vertical.
Measured Stress
Vertical Component of Stress at Upstream Face of Cantilever
Pounds per Sq. In. Compression in Arches
Pounds per Sq. In. Compression Tension Cantilevers
DEVELOPED UPSTREAM FACE OF MODEL
Arch Stresses as determined from Tuckerman Strain Gage Measurements.
Cantilever Stresses as determined from Tuckerman Strain Gage Measurements.

FIG. 5. MODEL OF GIBSON DAM
Stress Measurements and Trial-Load Calculations Compared

Results of the various measurements, together with a more detailed description of these experiments, will be given in the progress report of the Engineering Foundation's Committee on Arch Dam Investigation, which is to be published in the near future. Members of the profession are invited to participate in a full discussion of this model work and its application to Hoover Dam.

A sub-committee on model tests, appointed by Chairman Charles D. Marx of the Engineering Foundation's committee, is cooperating with the representatives of the Bureau of Reclamation in outlining, supervising, and conducting the investigations. This sub-committee is composed of J. L. Savage, M. Am. Soc. C.E., Chief Designing Engineer of the Bureau of Reclamation, Chairman; George E. Beggs, M. Am. Soc. C.E., Pro-

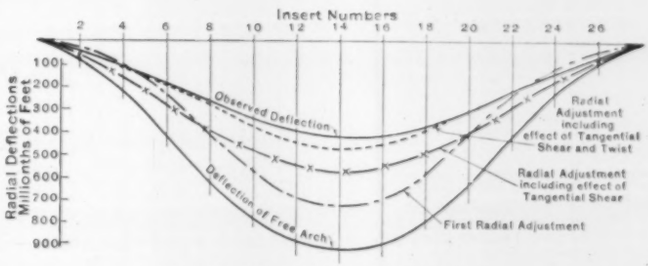

Insert Numbers
Radial Deflections Millionths of Feet
Observed Deflection
Deflection of Free Arch
Radial Adjustment including effect of Tangential Shear and Twist
Radial Adjustment including effect of Tangential Shear
First Radial Adjustment

FIG. 6. MODEL OF GIBSON DAM
Temperature Deflections, Observed and Calculated

fessor at Princeton University, Princeton, N.J.; Raymond E. Davis, M. Am. Soc. C.E., Professor at the University of California, Berkeley; F. R. Dungan, C. L. Eckel, and H. J. Gilkey, all Members Am. Soc. C.E., and professors at the University of Colorado, Boulder; D. C. Henny, M. Am. Soc. C.E., Consulting Engineer of Portland, Ore.; Julian Hinds, M. Am. Soc. C.E., Chief Designing Engineer of the Metropolitan Water District, Los Angeles; Ivan E. Houk, M. Am. Soc. C.E., Senior Engineer of the Bureau of Reclamation, Denver; Fred A. Noetzli, M. Am. Soc. C.E., Consulting Engineer of Los Angeles; W. A. Slater, M. Am. Soc. C.E., Professor at Lehigh University, Bethlehem, Pa.; and Fredrik Vogt, Assoc. M. Am. Soc. C.E., Professor at Norges Teknishe Hoiskole, Trondhjem, Norway.

The tests on the model of the Stevenson Creek Test Dam and the mercury-load tests of the model of Gibson Dam were made by Professor Vogt, who was at that time employed by the Bureau of Reclamation. The auxiliary concrete tests are being conducted under the direction of Professor Gilkey of the University of Colorado. The temperature tests of the model of Gibson Dam and the tests of materials for use in building a model of Hoover Dam were made by A. W. Simonds, M. Am. Soc. C.E., Engineer, who is now in direct charge of the work on models of Hoover Dam. The experimental program has been supervised throughout by Mr. Houk and Mr. Savage.

All engineering and construction work of the Bureau of Reclamation is under the direction of R. F. Walter, M. Am. Soc. C.E., Chief Engineer, with headquarters at Denver, and all activities of the bureau are under the general direction of Elwood Mead, M. Am. Soc. C.E., Commissioner of Reclamation, with headquarters at Washington, D.C.

Designing Wind Bracing for Skyscrapers

EXPERTS DISCUSS RECOMMENDATIONS OF STRUCTURAL DIVISION'S SUB-COMMITTEE

THE preliminary report of the Structural Division's Sub-Committee No. 31, on Wind Bracing in Steel Buildings, was presented before the Division on January 22, 1931, at the Annual Meeting of the Society in New York. It drew from structural experts who were present numerous constructive criticisms, which are presented here. Inasmuch as the report is a preliminary one, further discussion will be useful in the preparation of the final report, and discussions will be published as received in coming issues. Since the report appears in full in the March issue of CIVIL ENGINEERING, *only the eight recommendations from it are reprinted here.*

Relation Between Motion and Sensation

By DAVID C. COYLE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK

THE report of Professor Young's Sub-Committee on Wind Bracing is a tentative one and recognizes the necessity of more data. It should also be recognized that, even after all the necessary information is at hand, it will not be possible for an inexperienced man to design a tall tower out of a book. We need more facts for our guidance, but the judgment of an experienced engineer will always be the important factor.

One thing we do not know is how large gusts are and whether they have any periodicity. We are not interested in 1-min. gusts. The slowest time yet observed for one swing of a building is 3.75 sec., and a gust lasting exactly that length of time would produce the maximum effect. All the four dimensions of the gust are important — its length, width, depth, and violence.

Another unknown region that needs to be explored is the relation between motion and sensation. The sensation apparently does not depend on the acceleration—amplitude by frequency squared—but on some other function of the quantities. This is indicated by the fact that, other things being equal, stiffening a building will not reduce the acceleration, and yet the stiffer buildings seem to provide greater comfort. Incidentally, we need to distinguish between real sensations and illusions of motion resulting from objects in sympathetic vibration. It is also important to recognize the varying sensitivity of different classes of occupants, whether employees of the building owner, office tenants, or apartment dwellers. For one thing, people in an apartment are more often subject to disturbances of the organs of equilibrium, from one cause or another, than are those in an office.

By observing the frequency of oscillation of a building and obtaining the weight of the various stories, it is possible to compute the stiffness. Then, if we observe the static deflection, we can give a nominal, equivalent wind-pressure diagram, which will represent the effect, for a particular wind, of the pressure, friction, and suction combined. When we have that, it will be possible to obtain a more accurate idea of the sub-committee's recommended wind loads. In any case, it seems worth while to substitute in practice a straight-line diagram, to simplify the mathematics. I am inclined to believe that 10 lb. at the ground, adding 21 lb. per 100 ft. all the way up, would be a little better for a tall building than Mr. Spurr's suggested diagram with 30 lb. at the top in all cases.

The sub-committee is to be criticized for implying that the weight of the structure will affect the amount of the deflection. The walls and floor, as loads, affect the oscillation frequency, but they have no effect on the amplitude, except that the walls may stiffen the building and the weight of the walls and floors may increase the size of the steel. These indirect effects should not be allowed to confuse the fact that inertia does not affect the deflection of a cantilever under load. Because of the effect of the dead weight on frequency, and hence on acceleration, it is obvious that the allowable deflections for a tower of light construction would have to be different from those for towers

RECOMMENDATIONS OF THE SUB-COMMITTEE

1. That the prescribed wind force for buildings for the first 500 ft. of height be a pressure of 20 lb. per sq. ft., and that above this level it be increased at the rate of 2 lb. per sq. ft. for each 100 ft. of height.

2. That in no member should the stresses due to the combined action of this and all other loads exceed 75 per cent of the elastic limit of the material, nor should the overturning moment due to wind force exceed two-thirds of the moment of stability due to dead load only.

3. That for structures with rounded roofs, such as armories, hangars, and drill sheds, and for mill buildings or buildings with large open interiors and walls in which large openings may occur, consideration be given to the possible necessity for dividing the wind force into pressure and suction effects.

4. That, in calculations for strength, the walls and partitions of a tall building be ignored and the structural frame be required to resist 100 per cent of the recommended wind load.

5. That the various braced bents passing through a floor be considered as taking loads only in proportion to their rigidities.

6. That structural frames be so designed as to insure that deflections and vibrations will be kept within such limits as to render buildings comfortably habitable.

7. That engineers having to do with tall buildings undertake to determine experimentally the actual horizontal movements of buildings of various types and proportions, so that means may be devised for predicting the behavior of a building under wind force.

8. That, in the interests of rigidity and economy, deep rather than shallow bracing be employed wherever it is at all practicable.

with brick walls and concrete floors. It must also be observed whether the floors remain plane after bending, for it is obvious that the accuracy of any theory depends on this point.

We are only at the beginning of the science and art of tall-building construction. Our former naive methods were, in careful hands, adequate for pioneer purposes, but it is now time for a more sophisticated and developed art.

Higher Wind Pressures Recommended

By ALBERT SMITH
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, CHICAGO

IN connection with the sub-committee's report on wind bracing, I suggest the addition to the second recommendation of a limitation of unit stress for compression members for wind only or for combined stress, and for combinations of direct compression and bending.

Also, I suggest that, instead of specifying the limitation of the moment of stability of the building as a whole, the vertical wind load carried by any column be limited to three-quarters of its dead load. The moment of stability, due to dead loads of an irregular building, is hard to compute and may not coincide with the moment of stability of the dead load carried by the bracing system.

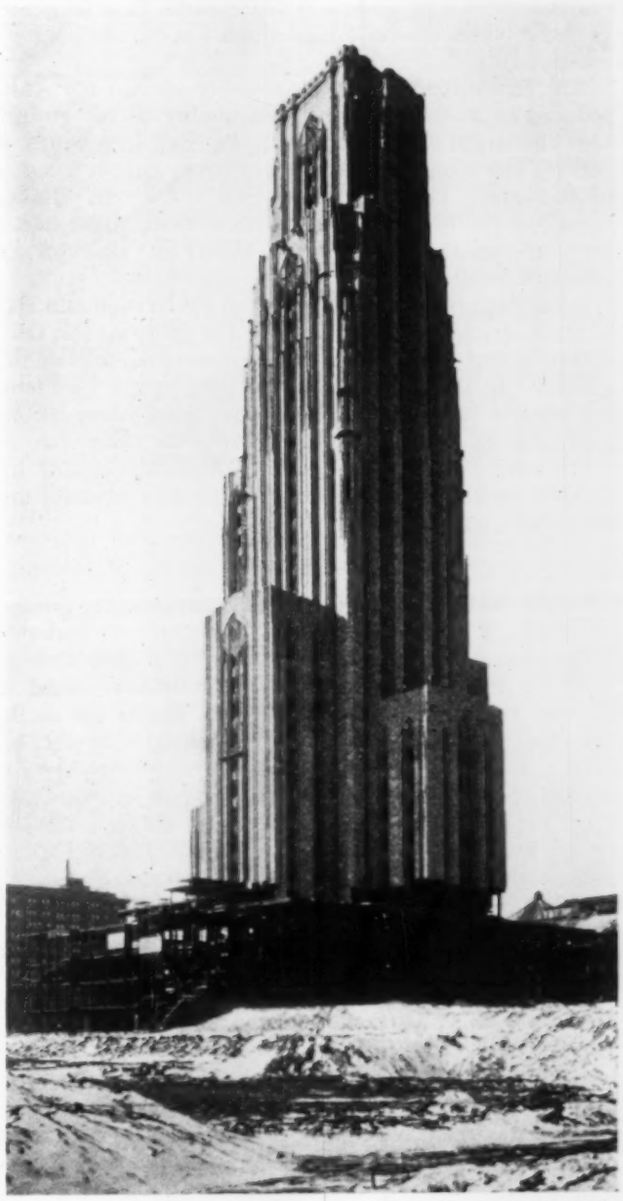
In buildings with only one basement, there are cases in which considerable moment is carried into footings which also receive a large, direct wind load. I think a limitation of stress in footings would be worth while. With these exceptions, I agree with recommendations two to eight.

I particularly approve the third recommendation, which advises attention to suction loads on large roofs. Many years ago I proposed that, even in small trusses, all members be made capable of resisting compression and that trusses be anchored, and I demonstrated by tests the occurrence of forces which could destroy light roofs not so protected.

The resistance to revising our practice in respect to wind loads on roofs seems to be due to inertia. In his work on *Wind Stresses in Buildings*, Mr. Fleming expresses his surprise that more development has not taken place in the twenty years during which the subject has been discussed. But he shows diagrams for wind stresses from a loading which includes downward panel loads on the windward side, and gives the Duchemin formula as a basis for determining the wind pressures on slopes. Since the Duchemin formula gives pressure units, which are not only incorrect in amount but are likely to be incorrect in direction, it is only by accident that it could be right.

TESTS ON VIBRATION

In regard to vibration, it is my opinion that, while tests on vibration in 40-mile winds are valuable, the real test of period and amplitude comes with 60- or 70-mile winds. There is probably a point at which the stiffness of partitions and walls in reducing the deflection and increasing the frequency is overcome, and we probably get deflections at the maximum wind much greater than the proportionate pressure would indicate. It is in this zone of pressures that the maximum stiffness of the structural frame is needed.



UNIVERSITY OF PITTSBURGH CATHEDRAL OF LEARNING

The first recommendation, specifying the unit pressures to be used in building design, gives units which are, in my opinion, much too low.

As I follow the sub-committee's reasoning, an observed velocity at New York of 74 miles per hour (5 min. maximum) is increased to 91 miles per hour for a 1-min. maximum. This 91 miles per hour is then squared and multiplied by a coefficient of 0.0033 to give the pressure of 27 lb. per sq. ft. at a height of 454 ft. on each area unit of a tower.

I think that 91^2 should be multiplied by 0.004 giving 33 lb. per sq. ft. Dryden and Hill found, at the Bureau

of Standards, Scientific Paper 523, page 731, that a tower model with proportions 1:1:3 received a total pressure which can be expressed as $P = 0.00384\ V^2$, and they predict that higher towers will show a larger coefficient. Other observers have found that long rectangular plates receive a higher unit force than do square plates.

The committee's 27 lb. at a 454-ft. elevation is then reduced to 20 lb. at 500 ft., presumably on the ground that the width of gusts is small and that, in a width of 100 ft., the 1-min. maximum will affect only a fraction of the area. This is true only for low levels. Baker found, at the Firth of Forth, that a 20-ft. target had a long-time maximum only two-thirds of that on an adjacent small plate.

Some unpublished data, collected by Dryden and Hill at the Bureau of Standards, show that gusts are less than 120 ft. wide. These tests, however, were made near the ground. In *Wind Stresses in Buildings*, page 53, Fleming quotes Stanton's conclusions from observations taken on the high-level footway over the draw span of the Tower Bridge in London. These conclusions indicated that gusts of practically uniform intensity for the whole structure might occur.

SIZE OF GUSTS

It is probably sufficiently proved that near the ground the width of gusts is small, but it is not proved that this is the case at a height of 150 ft. or so in a clear airway. Where a comparatively steady high-velocity wind is blowing between 1,000 and 2,000 ft. above the earth, the gusts of which we have record originate by the deflection of masses of air from the swiftly moving stream toward the earth. It is not reasonable to suppose that these deflected masses are splinters of air currents less than 100 ft. in width. On the contrary, it is logical to assume that they are very much larger masses which, as they approach the earth, are split up successively by the roughness of the surface of approach and the infiltration of the slower currents below. The maximum velocity at the center of the gust is probably indicative of the velocity of the main air current above. Thus a 1-min. velocity of 91 miles per hour at 454 ft. shows a much greater 30-sec. velocity and is ample justification for assuming that the main current of air is traveling much faster than 100 miles per hour.

The large number of somewhat conflicting data on the increase of average velocity with increase in height do not conflict with this theory of the wind structure. Since the characteristics of the approach surface are different for each observer, the results should be different.

The sub-committee has selected a unit pressure which increases with height, roughly in accordance with average gust velocity, to a maximum of 40 lb. It is my contention that we should start with the 40-lb. pressure ($100^2 \times 0.004$) for, say, 1,500 ft. and not diminish it until we reach the elevation at which we are sure that the width of the gust having an average pressure of 40 lb. is less than the width of the structures to which we propose to apply the unit. I believe that this point cannot safely be taken as higher than 500 ft. above the sidewalk, or 300 ft. above the base of the clear airway.

I propose that the pressure units should be 40 lb. above 500 ft. from the sidewalk, 35 lb. between 400 and 500 ft., 30 lb. between 300 and 400 ft., 25 lb. between 200 and 300 ft., 20 lb. between 100 and 200 ft., and 15 lb. below 100 ft. I have no confidence that these pressure units will not be exceeded in New York during the next twenty years, but I am confident that, in buildings carefully designed for the stress units set forth by the sub-committee and for these pressures, there will be no overstrain that will damage the structural frame.

These units give, for a 1,000-ft. tower, 56 per cent more than the sub-committee's units would give. They will probably require either additional column steel or the use of a high test steel for columns. They may double the cost of the wind bracing.

WIND BRACING COSTS NOT EXCESSIVE

The addition of 1 or $1^1/_2$ per cent to the cost of the structure is not a large amount to pay for the security of twenty to thirty thousand lives. The stiffness of the building may be designed for any convenient proportionate set of units, but when the design is so made, the wind bracing members should have a margin of safety for elastic action under the stresses from the worst probable wind load. To adopt low pressure units, on the ground that the bracing will be designed for low fiber stress, is to leave the field open to those who design bracing with large dead-load secondaries, or with the inelastic yielding upsetting the stiffness balance of the bays; or to those who, regarding the low fiber stress as giving a factor of safety, make rapid and rough calculation of stresses. The pressure units should truly represent the loads to be endured.

The responsibility of the Society in this matter is very great. Those who insist on designing for loads greater than those recommended by the Society will before long be out of business. If we allow considerations of economy to deflect our judgment in this matter, we will be responsible for any trouble that comes from designing for indeterminate stresses computed from inadequate loads.

Redesign of Wind Bents Impracticable

By ROBINS FLEMING
ENGINEER, AMERICAN BRIDGE COMPANY, NEW YORK

AN important step toward the solution of a puzzling problem is the progress report of the Structural Division's Sub-Committee on Wind Bracing in Steel Buildings. The thanks of the structural engineering fraternity are due the sub-committee for its report.

This report ends with eight recommendations, which are worthy of careful consideration. To take them up one by one, the first is to be heartily commended. The sub-committee has given a definite minimum wind pressure which should be assumed. It is observed that no exceptions are made for any relations of height to base, and this is as it should be. The wind blows on all buildings; in the built-up portions of cities it may blow on the street side, or adjacent buildings may be removed. Building codes and specifications vary in their require-

ments for resistance to wind pressure, specifying pressures as low as 10 lb. and as high as 30 lb. per sq. ft. With this wide variation, a decision on the pressure to be assumed is perhaps of greater importance than one as to how the wind stresses shall be distributed.

The second recommendation should also be heartily endorsed. The third is important, but I feel that the effect of suction has often been unduly magnified. In mill buildings it seldom need be considered. Usually, although not always, there is a saving but it is small, and an objection to taking advantage of it is that, with a monitor along the ridge of the roof or openings in the sides of the building, the closed roof may become a partly open one, thus changing the conditions for which the assumptions were made.

As to the fourth recommendation, it is a good one, but emphasis should be placed upon the word strength. Walls and partitions add to the rigidity of a building even if they cannot be counted on for strength.

Number 5 is sound theory but usually impracticable. The recommendation necessitates both a preliminary and a final design, and the time allowed the engineer for designing a proposed building will seldom permit this. Another serious difficulty is that many who design high buildings lack the necessary knowledge to make use of the recommendation. Again, all high buildings do not require the same consideration. The 40- and 50-story tower buildings are in a class by themselves and should receive special study.

There are 5,000 buildings in the United States of 10 and more stories in height, of which nearly 400 are more than 20 stories high. It is safe to say that, of those having 20 stories and under, not one in 100, and of those more than 20 stories high, not one in 10, has been designed in accordance with the sub-committee's fifth recommendation. Moreover, there was no need of their being so designed.

How can the sixth recommendation be followed? How shall a working "deflection index" be obtained, and if obtained, how shall it be applied in the design? As the subject is comparatively new, further developments will be awaited with interest.

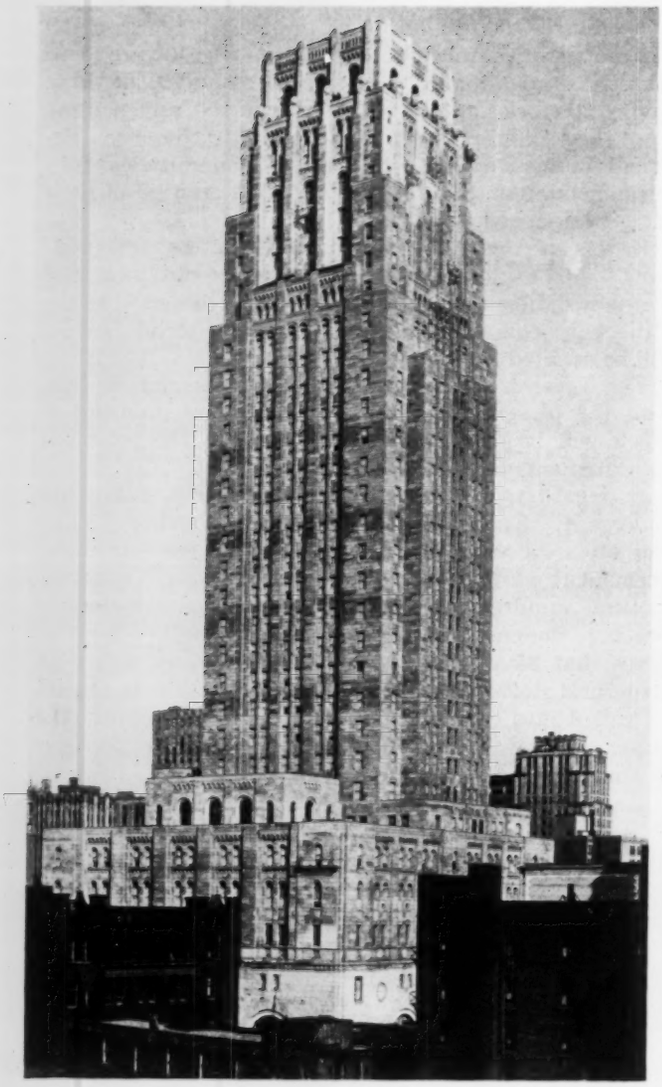
The seventh is an excellent recommendation but, with the present attitude of owners, it is doubtful if much will be accomplished. Where are the promised measurements of the Chrysler Building?

In regard to the eighth recommendation, I heartily endorse it. Knee braces add greatly to rigidity. They can often be used in bays around elevator openings, permanent partitions, and exterior walls. It is architectural requirements that usually necessitate shallow bracing; the engineer is often obliged to follow a set of plans that have been drawn up without any regard to structural steel requirements. Instead of this, he should be called into consultation with the architect from the start. This was done with marked success in the case of the Empire State Building.

As this is entitled a "progress report" it is inferred

UPTOWN NEW YORK, 42D STREET DISTRICT

Left to right, Empire State, 500 Fifth Avenue, Arnold Constable and Company, 22 East 40th Street, Lefcourt Colonial, Lincoln Building, New York Central Building (with the low spire), Waldorf Astoria Hotel (under construction), the Chanin Tower, and, on the extreme right, the Daily News Building, and the Tudor City Apartments.



CANADIAN BANK OF COMMERCE BUILDING
TORONTO, ONTARIO

that other reports are to follow. The matter of stiffness should be given special attention. The fifth and sixth recommendations should be enlarged upon.

If it is the intention of the present sub-committee to suggest any method for figuring wind stresses in high buildings, I strongly urge that they present the application of the suggested method to a specific case. By all means, a numerical solution should be given. The wind stresses in the bent of a 20-story building could well be chosen. Any proposed method should be such that it can be used by those engaged in the design of tall buildings.

Another subject that could profitably receive the attention of the sub-committee is that of details. It is as important to have columns and girders well connected as it is to have them well designed. The stiffness of a steel frame depends largely upon its connections. As buildings are mounting to greater heights, it is becoming more imperative that greater attention be given to details. This is particularly true of apartment houses.

More Wind Pressure Data Required

By AUBREY WEYMOUTH
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, POST AND MCCORD, INC., NEW YORK

THE Structural Division's Sub-Committee is to be congratulated on having presented a progress report which provides considerable food for thought on the part of those who are interested in the design, construction, occupancy, and ownership of high buildings.

In view of its recommendations for experimental work, it will probably be gratifying to the sub-committee to know that the Research Committee of the American Institute of Steel Construction has under way a series of observations on a recently constructed building, which perhaps presents a more interesting opportunity for experimental work at the present time than any structure in the country.

The sub-committee has presented numerous data on wind velocities in different localities and at different heights. But there seems to be a lack of data concerning the actual pressure on the surface of high tower buildings; and in the absence of such data it does not seem that the sub-committee is justified in predicting a graduated pressure based on 30 lb. at the top.

We do know that any number of buildings in New York, some of which are over the 500-ft. limit, have been designed with a considerably lower unit pressure than is here recommended, and that these buildings seem to be comfortably habitable.

With respect to deflection in the buildings, an attempt has been made to check the actual deflection against a calculated one. The results have been unsatisfactory, which seems to indicate that considerably more stiffness is added to the steelwork by the materials of construction than the sub-committee is willing to credit it with. That seems to be the only explanation of the situation; and until we have found some way to evaluate this additional stiffness from the materials of construction, it does not seem that we have the facts upon which we can predicate an accurate analysis of wind bracing.

Self-Recording Deflection Apparatus Needed

By G. A. MANEY
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROFESSOR OF STRUCTURAL ENGINEERING,
NORTHWESTERN UNIVERSITY

THE well considered conclusions set forth in the sub-committee's excellent report will undoubtedly find a high percentage of agreement in the minds of those who read its concise and definite recommendations.

The fourth, fifth, and seventh recommendations pave the way for a forward step in our methods of analysis of wind stresses and in our knowledge of wind action. Most of us will feel relieved at the conclusion that strength of

walls and partitions be ignored. Until some one can tell us specifically how, when, and why a partition or curtain wall resists wind, I will insist that the fourth recommendation is 100 per cent right.

My comment on the fifth recommendation is that, if adopted in our building codes, it will eliminate the now general use of a large variety of highly inaccurate approximate methods. I am working on approximate and workable schemes of solving the equations of the accurate methods of analysis. My work has so far brought out a point worth considering, namely, that the secondary wind stresses due to column shortening in a bent of more than two bays in depth greatly reduces the normally lower shear components developed in the outside column tiers. The division of wind between the bents of a building in the ordinary case of rigid floors is a big problem, so far almost ignored in practice, which the fifth recommendation opens up.

The seventh recommendation should be emphasized. The total horizontal deflection at the top of a high building, as measured by equipment which is self-recording and can be left permanently in place, is greatly needed and will give a definite measure of stresses that must actually exist under bad wind conditions. We are working on a set-up of apparatus which will attempt to do this, and if some of the consulting engineers in charge of the larger skyscrapers would install such apparatus it would not be long before the highly speculative features of design for wind resistance could be eliminated.

Column Shortening and Design Loads

By H. V. SPURR

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, PURDY AND HENDERSON, NEW YORK

THE report of the Structural Division's Sub-Committee on Wind Bracing in Steel Buildings deserves the careful consideration of all engineers who are concerned with the successful design of high buildings. The four main topics considered have been well chosen, and the summary of recommendations at the end of the report should have great weight.

Under the first topic, the magnitude and character of the wind force to be used for the purposes of design of the structural frame have been prescribed. The loads proposed, taken together with the limitations of unit stresses, furnish a yardstick for strength. If we assume that a unit stress of 27,000 lb. per sq. in. represents 75 per cent of the elastic limit, this provision for strength is consistent with existing building codes. For buildings about 1,200 ft. in height, the recommendations of the subcommittee are substantially in agreement with the new code of the City of New York, which specifies a wind load of 20 lb. per sq. ft. without any increase in unit stresses for wind load alone. We may, therefore, compare a load of 30 lb. per sq. ft. and allowable unit stresses of 27,000 lb. per sq. in. with a wind load of 20 lb. per sq. ft. and a unit stress of 18,000 lb. per sq. in. Structural members designed for the condition of wind alone would

MATHER TOWER, CHICAGO

be identical in either case. A similar comparison may be made for members whose sectional area is controlled by wind load combined with live and dead loads.

For heights greater than 1,200 ft., the recommended load is more severe than the legal requirements in New York. The proposed load diagram shown in Fig. 2 of the report would, in my opinion, produce horizontal shears in the lower stories of exceptionally high buildings which are, perhaps, unnecessarily severe when applied to the majority of buildings. Generally speaking, buildings of extreme height will present very large areas of exposure, and the great turbulence of the wind will prevent synchronizing maximum wind pressures over such large areas.

It should be borne in mind by the designing engineer that any wind load used for the purpose of design is nominal only and can never represent the actual load condition. It would be more reasonable to use a triangular loading for extremely high buildings in order to reduce the shears in the lower stories, with resulting

economy in material in the web system and in the field riveting.

The allocation of wind forces to the various bents has been well covered and is very important in high, slender towers. In fact, no rational design can be carried out without a proper distribution of load to the different bents.

RIGIDITY OF STRUCTURES

The sub-committee has seen fit to recommend a careful consideration of deflections. As buildings increase in height the elastic behavior of the frame becomes very important. The greatest hope for a fuller understanding of the dynamic effects of wind on tall structures lies in a study of the structures themselves. In order to study a given building with a maximum of intelligence and understanding, one must have some conception of the theoretical rigidity of the frame. In order to determine the approximate rigidity of the frame under wind forces, it is necessary to apply a definite load to the frame and to limit the theoretical deflection under that load. It therefore becomes necessary to proportion the structural members by practical methods of analysis which may be used with understanding by designing engineers generally.

It is not considered necessary that the same coefficient of rigidity be used in the actual design of all buildings. There is opportunity for the exercise of judgment in this respect, but it is particularly important that some yardstick should be adopted as a standard for comparing structures with one another on the basis of rigidity. Under these circumstances, the observations of wind effects on buildings may be made with some hope of ascertaining the essentials of the dynamic action of air currents on buildings of various sizes, shapes, weights, and exposures.

UNIT STRESSES

The use of a yardstick is not new, either in economics or engineering. In structural engineering, however, standards of design have usually included loadings and unit stresses only. In designing railroad bridges, loadings have been conventionalized; and such loadings, when tied up with a specification covering unit stresses, material, and workmanship, constitute yardsticks of strength. Similarly, the building codes of our principal cities specify live loads, allowable unit stresses for design purposes, materials, and workmanship. The live loads stipulated are nominal only. They are not factual, but engineers accept them as representative standards of good practice. Buildings designed under these conventional loadings are actually subjected to variations from these loads. This is not confusing to experienced designers, who do not lose sight of the mutual significance of loads and stresses.

In everyday calculations of the designing engineer, the value of "E" is largely forgotten. The high modulus of structural steel has made the consideration of deformation unnecessary in most structural designing, and this value has been relegated to the background. Conditions would be quite different if the modulus of steel were only one-third of its actual value.

Deformation or strain becomes important as structures increase in height. This is true even under vertical loads. In very high buildings the question of column shortening is important, as any difference in strain between adjacent columns may accumulate to a substantial amount in the upper stories, if the assumed loading does not correspond with the actual loading. For this reason, dead loads should be carefully analyzed and columns designed with the idea of keeping the differentials of strain at a minimum. Some thought should also be given to the construction program and to effecting the introduction of material into the structure in proper sequence, in order to limit the variation in strain in the columns while the building is under construction.

Wind loads are dynamic and of infinite variety. Similarly, no assumed load is factual, but there is bound to be a relation between the assumed load and the range of actual wind forces which the building must withstand. If the nominal load is wisely chosen and the proper rigidity secured under the assumed load, the building will behave well. The logic of this is self-evident. The problem is to develop the proper yardstick by experience, and this cannot be done thoughtlessly. In the years to come, there will probably be projected several high buildings, which will make admirable test pieces for the observation of wind effects, if they are so designed that their theoretical rigidity may be approximately estimated. For this purpose, the structural layout should be fairly regular and the masonry content at a minimum. In order to make analysis of the structure possible, the web system should be proportioned to prevent vertical distortion in panels by proper distribution of the shears.

I believe that the structural engineer should be prepared to take a more prominent part in the general planning of our very high buildings in respect to their stability, strength, and rigidity to resist lateral forces. Much depends upon the soundness of our conception of the physical aspects of the problem.

Observations on Size of Gusts

By E. P. GOODRICH

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK

I HAVE long endeavored to discover the size of wind gusts. My first observations were in reference to the swinging of the doors of a pier, which was over a quarter of a mile long. Other observations were made on the ripples which played across the surface of a fairly still pond. I have often been at the seashore and watched the wind blow off the top of the waves as spume. Also, I have observed the deflection of window panes on the side of my apartment house and my office building. A gust about 50 by 50 ft. seems to be most common but many are smaller. From many considerations I have been led to conclude that the gross pressure varies as the logarithm of the total area.

The question of suction has also been of interest to me. With a rather sensitive aneroid barometer, I have made observations around the larger stacks on various transatlantic vessels at sea and I have found very definite indications of a relationship between the windward and the

leeward sides of the stacks. The same observations applied to my apartment house and office building indicate that suction on the leeward side is almost identical with the extra pressure on the windward side.

In one particular, the design of high concrete buildings must be different from that of steel structures, for I discovered by analysis of one such building that, if each floor were entirely independent, the expected wind pressures would not overturn any one of them. Of course, those at the bottom, having the extra weight on top, would hardly have moments produced in the columns which would carry the resultant away from the center more than a fraction of the diameter.

Meager observations on certain mill buildings seem to indicate that the columns and structural members to the windward carry a greater portion of the stress than those to the leeward, probably due to lack of rigidity of the construction joints.

The question of wind pressures seems to me one of great importance, even though the total cost involved in wind bracing is minor, being only 3 or 4 per cent of the total cost of the structural work. However, the economic situation will ultimately demand that even such percentages be reduced.

Importance of Wind Bracing Connections

By W. M. WILSON

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RESEARCH PROFESSOR OF STRUCTURAL ENGINEERING,
UNIVERSITY OF ILLINOIS

IN designating its recommendation "a progress report," the Structural Division's Sub-Committee infers that it expects to continue working, and I wish to make some suggestions for the future.

Probably there is no instance in which the structural designer encounters greater differences in practice than in the design of the details connecting wind-bracing girders with the columns. The strength of a given connection, computed by one method in vogue, differs from that obtained by other methods. This difference in practice is due to a lack of knowledge, so I suggest that the committee study methods of designing the connections for wind bracing.

I am glad to know that the effect of stiffness of frames on the distribution of wind load has finally been recognized by American engineers. The deflection of a frame made up of rectangles having rigid connections at the corners can be computed, although the problem is complicated. If the connections are not rigid, the deflection depends upon the slip that takes place. The few tests that have been made indicate a wide variation in the rigidities of various types of connections. The sub-committee might, therefore, investigate the subject of the rigidity of connections used in wind bracing tall buildings.

The sub-committee has seen fit to express the allowable design stress for wind bracing in terms of the yield point of the material. I recently had occasion to write a formula, based on some previous experiments, governing the design of a different type of structure. After I had expressed the allowed stress in terms of the yield-point strength of the material and had published the conclusions, I apprehensively realized that that was not the accepted mode of expressing allowed stress. I do not claim that my method is unique, but it is certainly unusual.

We are using material—steel, if you wish—which has considerable variation in physical properties, due to composition, method of rolling, thickness of section, and heat treatment. It seems to me that to try to cover all of these variables with a fixed unit stress is utterly absurd, but the practice of thinking in terms of yield point has a still greater advantage. We may become "yield-point conscious" and also curious as to the physical properties of the materials in actual use.

I agree with our veteran wind-bracing designer, Mr. Fleming, for whose work I have the greatest admiration, that the computations for the deflection of a bent due to a given load are intricate and that insistence upon them will greatly complicate the design. It may never be the practice of American engineers to compute accurately the theoretical deflection of the bents that are actually built. However, I think that, with a knowledge of the rigidity of the connections and of the behavior of elastic continuous material, we can arrive at empirical equations which will give, at least approximately, the relative rigidities of two or more bents which make up a part of the same frame.

I believe that the distribution of wind pressure among the bents of a building will continue to be made by empirical equations. My objection to the empirical equations used, at least by many engineers, is that no account has been taken of the difference in the rigidity of the various bents. However, it seems probable that the distribution of the wind pressure among the bents of a building will be more nearly correct if the rigidity of the bents is considered, even by an empirical method, than if it is neglected entirely.

Effect of Shape of Buildings

By H. L. DRYDEN

CHIEF, AERODYNAMICAL PHYSICS SECTION
U.S. BUREAU OF STANDARDS

THE report of the Structural Division's Sub-Committee on the subject of wind bracing in tall steel buildings represents an important forward step, especially in the recognition of the desirability of analyzing the value of the wind load used for design purposes into the several factors involved. Values of the wind loads now used are in effect purely conventional and have little relation to the actual loads on the structure. The comparative strengths of two buildings cannot be inferred from a comparison of the wind loads used in their design, for the maximum stresses permitted in the steel also have an important bearing on the strength.

The use of conventional values for wind loads and permitted working stresses represents a temporary expedient adopted in the absence of knowledge. As soon as information is available concerning the magnitude of the real wind loads and the properties of the material

to be used, such an expedient should be discarded and the procedure revised to conform more nearly to the facts. The report of the sub-committee is a step in that direction.

It has been considered advisable by the sub-committee

L. C. SMITH BUILDING, SEATTLE, WASH.

to omit a rather large body of information on wind pressure obtained by model experiments in wind tunnels, except for one result of Eiffel which is considered obsolete by aeronautical engineers. Those experienced in wind tunnel measurements both in this country and abroad—particularly in Germany—believe that experiments on models of buildings furnish values of the wind pressure at a given speed, which are fully as reliable as the results of corresponding measurements on airplane models. These experiments show the very great influence of the shape of the structure, a factor not considered by the sub-committee. The pressure on a thin flat plate has absolutely no relation to the pressure on a building. For a given projected area and wind speed, the value of the wind pressure on structures of various shapes varies over a range of 5 to 1. The most striking illustration of the effect of shape is the ordinary elevated water tower, in which the wind force on the steel supporting frame, which looks to be a small part of the structure, is greater than the force on the water tank.

For several years the U.S. Bureau of Standards has been engaged in measurements on models of structures in a wind tunnel and, to some extent, in measurements of natural winds with a view to determining the effect of shape on the average wind pressure and also on the distribution of the wind pressure over the structure. Some of the results are described in Scientific Paper 523, and in Research Papers 221 and 301 of the Bureau of Standards, which may be obtained at a nominal cost from the Superintendent of Documents, Washington, D.C. My personal views and interpretation of the available experimental data are given at greater length in the *American Civil Engineers' Handbook*, fifth edition, by Merriman and Wiggin, pages 289 to 297.

Making Tests on Models of a Hangar

By LEROY W. CLARK

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PROFESSOR OF MECHANICS, RENSSELAER POLYTECHNIC INSTITUTE

THE report of the Structural Division's Sub-Committee on Wind Bracing is excellent, but I feel that one phase of this subject has been omitted, namely, the importance of making tests of models to determine the effect of wind pressures upon a particular type of building.

My interest in this method of studying wind pressures has been renewed by a study of wind effects upon hangars, made by Lt. H. McT. Sylvester, Civil Engineering Corps of U.S. Navy, while a graduate student at Rensselaer Polytechnic Institute. The tests were made in wind tunnels upon scale models of an actual hangar. Lieutenant Sylvester's conclusions substantiated those of Professor Smith, Dr. Arnstein, and others who have conducted similar model tests and proved the existence of astonishing conditions, especially in regard to suction, which was found to be an important factor. The incorrectness of the old wind pressure formulas was also demonstrated.

As Mr. Fleming has suggested, it is very difficult to secure an appropriation from owners for making tests upon a projected type of building. However, the current European practice of making model tests, especially for power developments, has repeatedly demonstrated their economy, and it would seem that an engineer is justified in making every effort to have such an item inserted in the estimated cost of the work.

While it is not certain that such tests would induce us to change the recommendations of the sub-committee as to loads, surely the work of Messrs. Dryden and Hill and of Lieutenant Sylvester has shown that wind pressures may differ widely from those commonly assumed. It is not unlikely that such tests might also settle the disputed questions of what a gust is and how much deflection will be produced by a gust as compared with a steady load.

It may be of interest to point out that Lieutenant Sylvester's thesis will soon appear as a number in the Rensselaer Polytechnic Institute's "Engineering and Science Series."

Reconstruction of a Large Spillway

By-Pass of Narrows Dam, Yadkin River, Designed and Built After Experimental Studies

By ROBERT F. EWALD

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HYDRAULIC ENGINEER, ALUMINUM COMPANY OF AMERICA, PITTSBURGH, PA.

ON the Yadkin River in North Carolina, in 1917, the Tallassee Power Company constructed the Narrows Dam, of the overflow, gravity type, arched in plan. An auxiliary spillway channel 100 ft. wide, to carry 150,000 sec-ft., was cut around the left end of the dam. It was realized that this channel would ultimately require a concrete lining, but because of the very hard rock through which it was cut, and to save interest on construction, the work was postponed. In 1919 a flood of 35,000 sec-ft. eroded so much rock and otherwise so seriously damaged the channel that, after an elaborate study of models, it was reconstructed and lined. In 1929 it safely carried 80,000 sec-ft. in the manner which had been predicted by these investigations.

THE wasteway here described, and called the "by-pass," is located on the Yadkin River near Badin, 40 miles southeast of Salisbury, N.C., and is part of the Narrows Hydro-electric Development belonging to the Tallassee Power Company, a subsidiary of the Aluminum Company of America. The Narrows Dam, an overflow structure, is described and shown in detail on page 528 of CIVIL ENGINEERING for March 1931.

In Fig. 1 are indicated the relative positions of the dam, power house, penstocks, abandoned spillway tunnels, and the by-pass in its original form. Also shown is the topography of the flat area lying between the river's edge and the end of the by-pass, over which the water flows to the river. All the structures of this development are founded on an igneous rock called porphyry or rhyolite, which has a specific gravity of 2.9, and is very fine grained, very hard and durable, non-friable, and very resistant to erosion when unbroken. However, at the site of the by-pass it is very much broken up to a considerable depth by horizontal and vertical joints. As a rule, the joints are tight and but slightly weathered.

BY-PASS TO CARRY NORMAL FLOODS

In 1915, when plans for the development were being made, independent estimates by a board of engineers agreed that it would be necessary to provide for a maximum flood flow in the river of not less than 250,000 sec- ft., or 100 per cent greater than any flood for which recorded data were available. This board consisted of A. P. Davis, Edwin S. Fickes, John R. Freeman, and James W. Rickey, all Members Am. Soc. C.E. The matter of providing suffi-

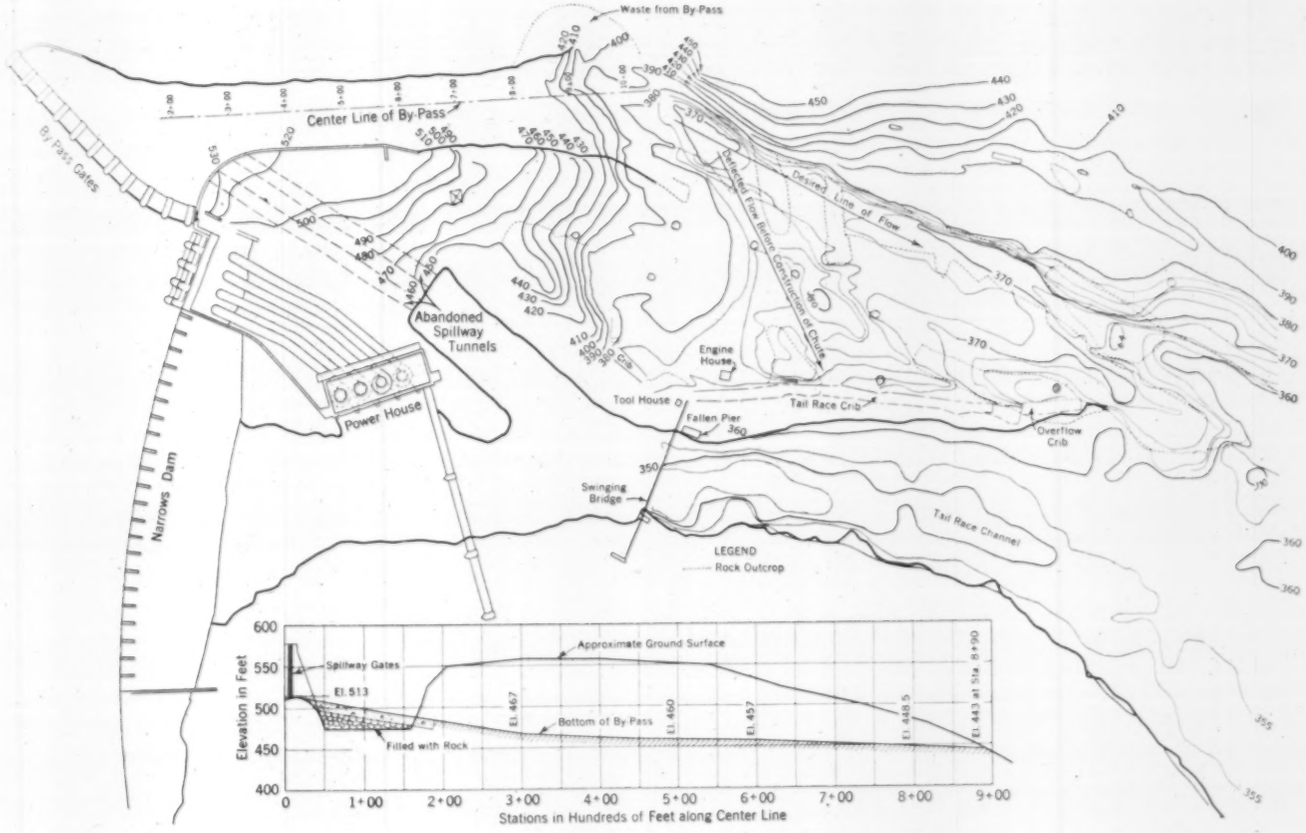
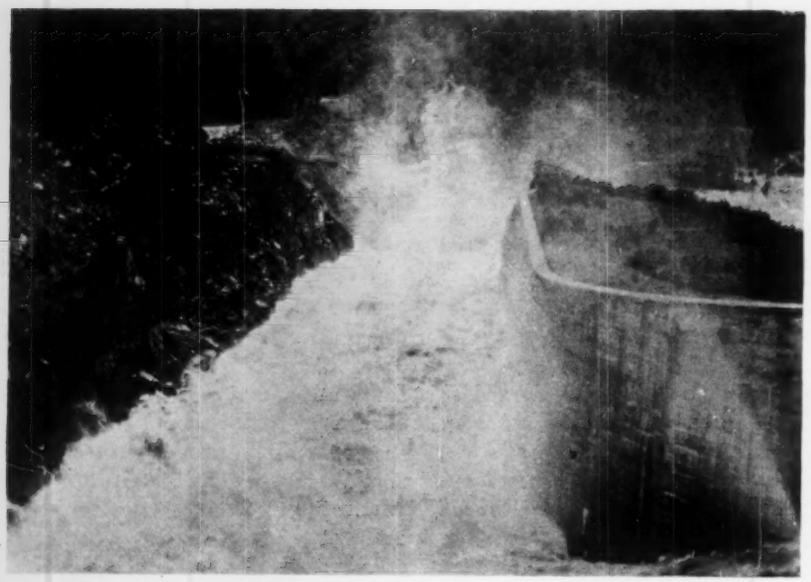


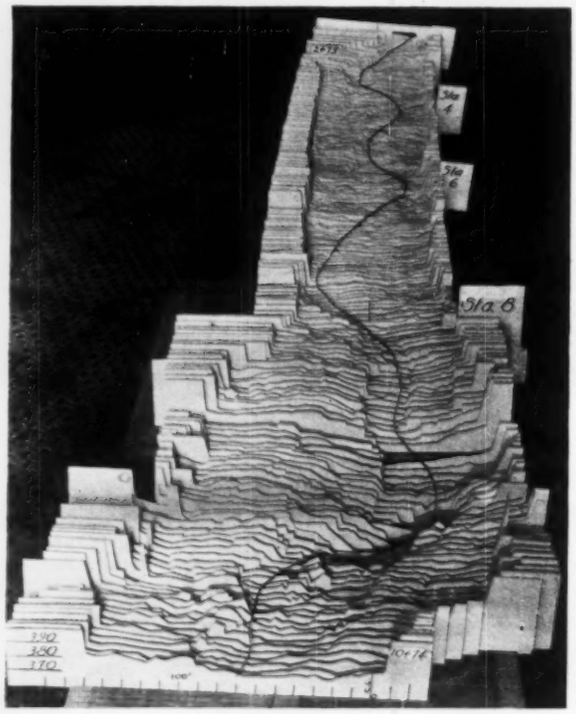
FIG. 1. TOPOGRAPHY OF ORIGINAL BY-PASS, NARROWS DAM
The Dam, Power House, and Abandoned Tunnels



NARROWS BY-PASS CARRYING 35,000 SEC-FT.
July 21, 1919

cient wasteway capacity was complicated by the existence of a pair of spillway tunnels with a possible maximum discharge capacity of 100,000 sec-ft.

These tunnels, constructed by a predecessor company, discharged near the site for the present power house. Owing to the shallowness of the river at the dam site, it was realized that if they were utilized and the additional 150,000 sec-ft. expected were carried over the dam, a very high and expensive secondary dam would be required to develop the stilling pool necessary to prevent excessive and dangerous erosion at the toe of the main dam. This secondary dam would seriously interfere with the location and operation of the power house. If no stilling pool were to be developed, then it would be necessary to carry the foundations of the dam very deep to make certain that they would not be endangered by excessive erosion and, in addition, the problem of keeping eroded material out of the tailrace would have to be solved.



MODEL BUILT UP OF CROSS SECTIONS OF THE BOTTOM
Survey of July 1923

Confronted by this situation, the board of engineers decided that it would be desirable to abandon the spillway tunnels altogether and to excavate around the left end of the dam a by-pass having a discharge capacity of 150,000 sec-ft., to carry all ordinary flood flows. Water would then spill over the dam only during flood flows in excess of 150,000 sec-ft., and it was estimated that 87,000 sec-ft. could pass over safely when the river channel below was carrying 237,000 sec-ft. Plans for the development were made and executed accordingly.

The by-pass was excavated through rock which was the same as that on which the dam was founded. As left by the contractor in 1917, and shown in Fig. 1, the channel was 100 ft. wide at the bottom and in places nearly 100 ft. deep. The board of engineers unanimously agreed that the bottom of the by-pass would eventually have to be lined with concrete but, owing to the labor situation then obtaining, and with the idea of saving interest charges for a number of years, it was decided to postpone this work. However, a concrete protection wall was built to a height of 50 ft. for a distance of about 500 ft. on the right side, and a heavy concrete apron was constructed downstream from the entrance gates for a distance of 100 ft.

The only flood of which a considerable portion was taken through the by-pass in its original unlined condition occurred in July 1919, and lasted three days. At that time the maximum discharge through it was 35,000 sec-ft. A photograph illustrates clearly the tremendous surging of the water on the irregular rock bottom. This flood tore out an enormous amount of fractured rock and so damaged the bottom of the by-pass that thereafter it was necessary to limit the flow through it. Even though discharges of more than 2,000 sec-ft. were rarely permitted, erosion continued at a rapid rate and it became more and more evident as time passed that, if it were ever to handle even a reasonable fraction of its designed capacity, extensive repairs would be required.

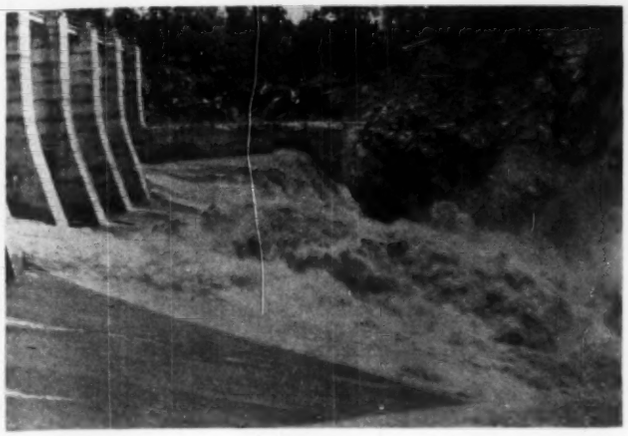
MODEL CONSTRUCTED

In 1923 a detailed survey was made, and typical sections from this survey, superimposed on the sections as left by the contractor in 1917, are shown in Fig. 2. A model was also constructed from the survey data by cutting sections out of cardboard to scale and mounting them in proper position on a wooden base. The survey showed that an average of 8 ft. of solid rock had been washed out of the bottom between Stations 3 and 8, and that a large hole was being developed in the vicinity of Station 9. This hole was rapidly being cut backward toward the head of the by-pass, as well as laterally, especially toward the left bank.

A deep, narrow, meandering channel was also being carved into the original bottom, as traced out by the string placed on the bottom of the model and here il-

lustrated. At the upper end, between Stations 2 and 4, the solid rock bank opposite the entrance gates had been undercut in some places for more than 20 ft. The extent of this undercutting in 1920 is illustrated as well as the conditions active in causing it, as photographed about a year previously.

Apparently it would be only a question of time before the bank would be so badly undercut as to result in serious slides. In the bottom of the channel, especially where the cut was the largest, the rock was originally in

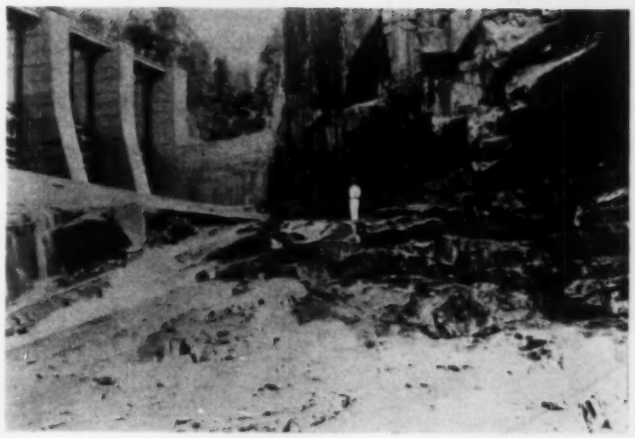


ACTION OF DISCHARGE FROM THE BY-PASS GATES
At the Entrance to the Channel, August 1919

better condition, but heavy blasting during excavation operations had shattered it to an unknown depth. In the vicinity of Station 9, the cut was so deep that all material with a weathered surface had been eroded, and all the exposed rock faces were bright and clean.

An illustration shows men with level rods standing on the cross section at Station 9. The bottom of the channel, as left by the contractors, was nearly level with the bottoms of the derricks, or about three times the height of the extended level rods above the bottoms of those rods. This will give some idea of the source of the enormous amount of material eroded and deposited over a distance of 1,000 ft. below the by-pass.

From the entrance of the by-pass down to Station 8, the actual velocity of the water probably never exceeded 30 ft. per sec., but the shattered condition of the rock made erosion relatively easy. In the vicinity of Station 10 the increasingly greater drop resulted in far higher velocities. Furthermore, the erosive power was tremendously increased by the milling action of the material picked up from above. For this reason, even though weathered seams were absent and joints were watertight, affording the water little chance to "take hold," the rock was rapidly ground away, leaving clean, bright surfaces. No blasting operations had been carried on within a hundred feet of this area and the rock was practically watertight, as the eroded pool always remained full of water even though its surface was several feet above the river. Although one of the hardest and densest rocks known—$2^1/_2$-in. drill bits penetrated not faster than $1^3/_4$ ft. per hour—it seems to have melted away like soft shale before a stream from a garden hose.



CLIFF DAMAGE OPPOSITE THE DISCHARGE GATES
Average Bottom Erosion 8 Ft. Below the Apron

In the hope of keeping most of the debris out of the tailwater channel, a series of rock-filled cribs had been built along its banks and across the path of the water from the by-pass, as shown in Fig. 1. It became apparent, however, that these cribs would be of little value during an unusual flood. It was therefore decided to line immediately the sides and bottom of the by-pass as far down as Station 8, and to protect the shattered and undercut left bank near the entrance to prevent its complete undermining. The lining would deprive the flowing water of its most effective tool for erosion, the material picked up in the upper end of the by-pass.

MODEL CARRYING THE EQUIVALENT OF 170,000 SEC-FT.
Good Flow Conditions Below the Gates

EXPERIMENTS ON MODELS SOLVE PROBLEMS

While the lining was being placed, experiments on models solved the problem of turning the water at the lower end of the by-pass in such manner that it would flow along the line marked "desired line of flow," Fig. 1, and enter the main river channel as far downstream as possible. Any material that was eroded from the flat would then be sluiced out and deposited in areas well away from the tailrace channel.

The lining of the by-pass above Station 7 was completed in 1924 and, during the time this work was under way, the projected experiments on the model were carried out. The results obtained in these tests led to the firm belief that a satisfactory solution had been found for the

problem of properly turning the water and reducing its velocity. In accordance with the data furnished by the model, the channel downstream from Station 7 was shaped and lined with concrete, the work being completed in 1925. The full drop of the water from elevation 541.0 (normal water level above the dam) to elevation 360.0 (tailwater level) was then accomplished over smooth concrete surfaces, and at the lower end the high velocities for ordinary flood stages were dissipated in a cushion pool.

EROSION AT STATION 9—NEARLY 40 FT. CUT AWAY
See Cross Section of Station 9 Below

MODEL DISCHARGING INTO STILLING POOL
Equivalent to 80,000 Sec-Ft.

CONSTRUCTION OF THE MODEL

It was assumed that the laws of hydraulic similitude had been fairly well established and that the performance of the model would be a reasonably accurate guide to the design of the prototype. In general, the results confirm the opinion now generally held that, in dealing with turbulent flow at high velocities, or with "shooting" flow as it is sometimes called, the principal reliance for accurate design must be placed on the action of carefully prepared and intelligently operated models.

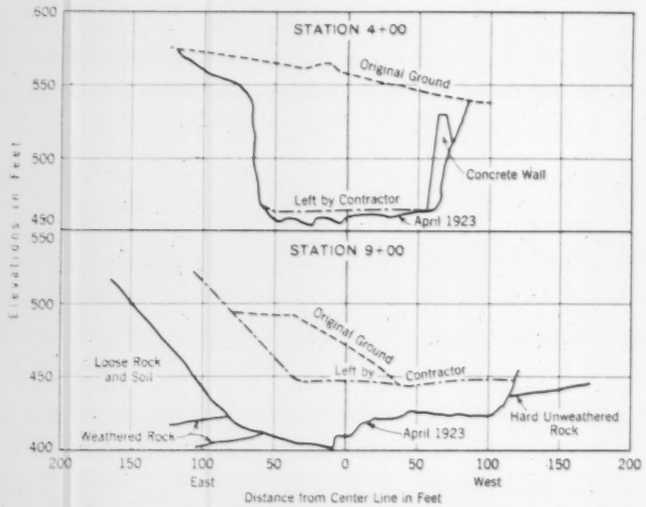


FIG. 2. CROSS SECTIONS SHOWING EROSION
In 1918, Before Reconstruction

The model was made of dressed lumber on a scale of 1:48. Water was supplied by a centrifugal pump with a maximum capacity of 6 sec-ft., measured at the extreme downstream end of the model on a sharp-crested weir with end contractions. For discharges up to 130,000 sec-ft., the rating curve for the lower river channel—downstream from the power house and below the outlet of the by-pass—had been fairly well defined by measurement. For greater flows, water surface elevations in the lower channel were set in accordance with a logarithmic extension of the rating curve.

Beyond establishing by experiment the carrying capacity of that portion of the by-pass above Station 7 and the necessity of obtaining uniform channel surfaces to prevent bad eddies, not much experimental work was done for the upper end of the by-pass. With a flow through the model equivalent to 170,000 sec-ft. (20,000 sec-ft. more than the desired capacity), there was a remarkably slight disturbance at all points in the upper end of the by-pass, and the test showed that the entrance as designed and built was ample to provide for the expected maximum flow. The results of the experiments were particularly gratifying in that they showed almost no surging along the wall opposite the gates.

As will be noted from the plans and pictures, a very large part of the water is forced to make a relatively sharp turn after passing through the entrance gates, and this is accomplished at maximum flow with almost no disturbance and with no weaving of the water back and forth across the channel, as often happens in wasteways, which the water is compelled to enter at a sharp angle. Data obtained from the model were used in determining the correct height of the walls, and in this respect alone the model paid for itself many times over. It was found that the old wall on the right side had been built from 15 to 20 ft. higher than necessary, and the same excessive height probably would have been repeated on the left side if the data from these experiments had not been available.

For that portion of the by-pass below Station 7, called the chute, it was found necessary to try a number of types of models with several variations of each type. More than one hundred conditions were tried and over two hundred pictures were taken during the course of the experiments.

TYPE OF CHUTE ADOPTED

As a result of the long series of experiments just mentioned, it was found that the most satisfactory manner of

turning the water into the desired path would be to start the turn at the upper end of the chute, where velocities were relatively low. This was accomplished by introducing a fairly sharp angle into the left wall near Station 7, by slightly narrowing the chute below that point, and by supplementing the turn by a sharp warping of the floor of the chute itself, so as to complete the turning moment on the water.

Thus the experiments and studies resulted in the Type A-1 chute shown in plan and section in Fig. 3. Unfortunately, in the prototype, the location of the left wall that produced the best action fell along the center of the little canyon, which had already been excavated by the flowing water, and this made construction very expensive. However, the action of this model indicated that no training works would be required downstream from the chute and, as the structure was narrower than any other form of chute tried and could be built entirely within the limits of the existing channel, it proved in the end to be cheaper than its nearest competitor in point of performance.

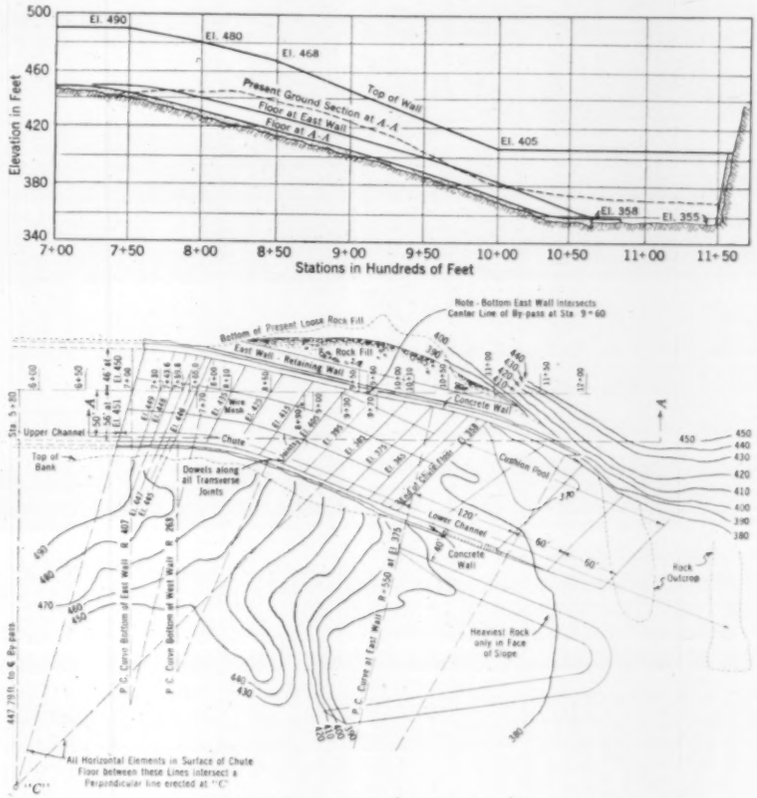


FIG. 3. BY-PASS RECONSTRUCTION DETAILS
PROFILE SHOWING ELEVATIONS OF FLOOR AND GROUND AT SECTION A-A
Also East Wall Elevations at Top and Floor Intersection

STILLING POOL AT END OF CHUTE

To prevent high velocities at the end of the chute from continuing downstream, and to reduce the erosive action on the channel, it was deemed advisable to develop a cushion pool capable of absorbing the energy of moderate-sized and frequently occurring floods. However, it was not considered economical to attempt to provide a cushion pool to handle the maximum possible flood, both because of the enormous size of the pool which would be needed for that purpose, and because it would probably be many decades before such a maximum flood would occur.

It was considered inadvisable to try to provide a pool adequate to cope with 150,000 sec-ft. through the by-pass, as it had been found by experience that 50,000 sec-ft. could be handled over the crest of the dam without serious erosive effects. By allowing this amount to pass over the dam, it would be necessary to take only 80,000 sec-ft. through the by-pass in order to provide for the largest flood of the previous century. The next thing to be done then was to determine by experiment the size of pool which would be adequate to take care of 80,000 sec-ft. down the by-pass.

The action of the model, with a pool at the end of the chute 300 ft. long and excavated to elevation 355.0, is also illustrated. The high velocities were absorbed without the development of whirlpools, as in other models. There was no concentration of flow along the left wall and the current was directed straight downstream, parallel to the left bank, with no components directed toward the bluff or the tailrace cribs. The effectiveness of the left wall at the upper end of the chute in crowding the flow toward its center is made apparent by the very marked hump of the water along the center line.

The cross sections in Fig. 4 show the actual water surface on transverse sections at the lower end of chute Type A-1 as compared to the next best type of chute tested for flows of 150,000 sec-ft. In Type A-1, the maximum depth of 20 ft. occurred 45 ft. from the left wall, whereas in the next best, Type A, the maximum depth of 26 ft. occurred at the wall. The most difficult problem was the elimination of the "crowding" along this wall, and the search for its proper solution was the principal reason for the use of so many variations in the models.

It would have been highly desirable to widen the chute at its lower end to 200 or even 300 ft. in order to thin

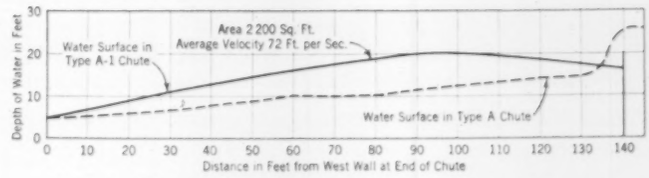


FIG. 4. COMPARATIVE WATER SURFACE CROSS SECTION
Model Types A-1 and A

out the sheet of flowing water, but experiments on the model showed plainly that, because of the high velocity, it would be impossible to get the water to spread to any extent. The practical limit of width at the lower end of the chute was found to be about 135 ft. With an average velocity of 75 ft. per sec., this means that, with maximum flow, the average thickness of the sheet of water at the end of the chute is more than 15 ft. It is difficult to conceive the enormous power inherent in a sheet of these dimensions flowing at a velocity of more than 100 ft. per sec.

CONSTRUCTION OF THE CHUTE

The chute was built substantially along the lines established by the model. The left, or east wall, in

STILLING BASIN AT END OF THE COMPLETED CHUTE
After the 80,000 Sec-Ft. Flood of October 1929

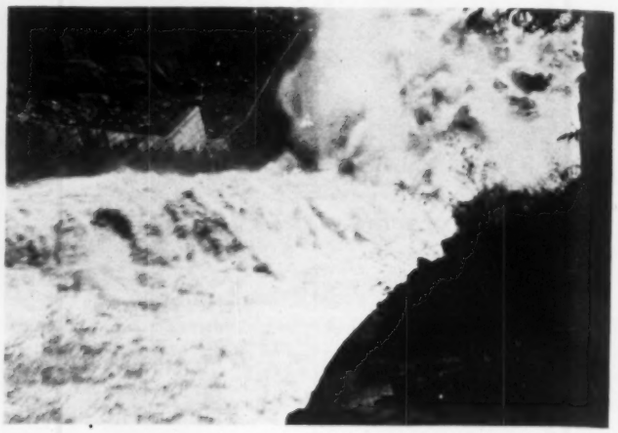
places 38 ft. high, was designed as a monolithic retaining wall backed by rock fill; and the floor of the chute, formed of concrete, was carried down to elevation 358.0, terminating on, and covering, part of the bottom of the cushion pool. As now excavated, the pool is adequate to cushion a flow of 80,000 sec-ft. without undue erosion. In time it will be enlarged to take care of much larger flows, the enlargement being the result of passing flows increasingly greater than 80,000 sec-ft. and depositing the eroded material under complete control. It is estimated that the additional eroded material will not be more than can be stored in the river channel without seriously raising the tailwater level. By letting nature do the work of enlarging the pool, it will ultimately be shaped accurately to fit the varying conditions of depth and velocity of the incoming water.

Owing to the great variation in temperature—from −15 to 130 deg. fahr.—to which the concrete would be subjected, the walls and floor were carefully subdivided by expansion joints located so as to come in the thinnest sections of the concrete. Along the edges of each block, dowel rods were sunk into the rock at 5-ft. intervals, to a depth sufficient to develop their full tensile strength. Aside from a few hair cracks less than 5 ft. long, no shrinkage cracks have been detected in the concrete.

At the beginning of the work, oakum and asphalt-filled expansion joints were used, but later the joints were made by setting creosoted cypress fillers while the concrete was being placed, and these have proved to be entirely satisfactory. As expected, the asphalt joints tend to wash out under high velocities and require considerable maintenance.

PERFORMANCE OF THE COMPLETED STRUCTURE

The completion of the by-pass was followed by several years of subnormal flow, and it was not until 1929 that the structure could be tested by flood flows of a magnitude comparable to that for which it was designed. A comparison of the photographs of the completed chute with those showing the model indicates that the general action of the prototype was portrayed by the model with a high degree of accuracy. There is much more surface agitation of the water in the prototype than in the model, a condition that has been noted by observers on other models; but the "humping" of the flow toward the center line of the chute is identical in both. The action of the water in the stilling pool, with 80,000 sec-ft. flowing through, is not quite the same in the prototype as shown by the model, because in the former only 34,000 sec-ft.



RECONSTRUCTED CHUTE IN ACTION
Hump Near Center Line with 68,000 Sec-Ft.

were being taken over the dam, while in the model the experiments were made with a water surface in the pool based on 50,000 sec-ft. coming over the dam. The relatively smaller cushioning effect in the prototype is made evident by a much greater disturbance in the pool.

PRACTICAL CONCLUSIONS

Experiments made during the course of this particular work did not add materially to theoretical knowledge on the subject of erosion, but they did point the way very clearly to the following solutions of the problem in hand: (1) reducing the erosion to a minimum; (2) directing the flow so as to prevent the filling-up of the tailrace channel; and (3) preserving the by-pass channel so that it would function when required.

The most important lesson taught by experience with the by-pass was that no hydraulic problem involving unprecedented conditions in the flow of water at high velocities should be considered properly solved until proposed designs have been checked, and possibly revised, by experiments on operating models. It is surprising how frequently and to what an extent preconceived ideas may be modified. It is true that previously there has been some difficulty in getting locations where such experiments could be made at a reasonable cost but, with the establishment of permanent laboratories devoted to this purpose, the building of costly temporary outdoor laboratories may now be avoided, and experimental work may be carried out at a very reasonable cost, considering the importance of the problem.

ACKNOWLEDGMENTS

Grateful acknowledgment is due E. S. Fickes and J. W. Rickey, Members Am. Soc. C.E., for helpful criticism, and to J. E. Warnock, Jun. Am. Soc. C.E., for assistance on the details of preparing this paper.

Great German Hydraulic Laboratory

The Research Institute for Hydraulic Engineering and Water Power

By HUNTER ROUSE

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ALTHOUGH the developed theory of the similitude of models has been proved to be a useful tool in hydraulic investigations, it is often difficult to accurately determine the factor of conversion. This great laboratory at Walchensee, by experimentation on models ranging from small scale to full sized, will give further confidence to the results of the study of small models and will bridge the gap between theory and practice. Because of its capacity for experiments on large-scale models and for determining the effect of the scale of models, it has been characterized as the greatest hydraulic laboratory in the world. In this paper, Mr. Rouse also records the comparative results of initial experiments on water-measuring devices checked against volumetric measurements. More detailed results in complete form will be printed in the "Proceedings" of the American Society of Mechanical Engineers this fall.

TO Oskar von Miller, founder of the renowned Deutsches Museum at Munich and responsible for the development and perfection of the Bavarian power system, is given first credit for the movement that has led to the creation of the world's largest open-air hydraulic experiment station. Engineers and investigators, for decades the sponsors of exceedingly small-scale experiments, had begun to realize the limitations and possibilities of error in model study requiring complete dependence on the theory of similitude, and they turned hopefully to a means of vindicating theory and practice in a more conclusive manner.

In April 1926 was organized the Research Institute for Hydraulic Engineering and Water Power, latest of the many branches of the Kaiser Wilhelm Society for the Promotion of Science. Contrary to the prevailing custom of placing laboratory management under the staff of a technical university, the new institute was made an independent organization, financed by such bodies as the national government and the State of Bavaria, the City of Munich, and a number of private power and industrial concerns, in return for the privilege of experimental investigation.

ORGANIZATION PURPOSES AND METHODS

The search for a desirable location for the new station was governed by several factors: constant water supply in sufficient quantity to provide for all future needs; a large unobstructed land area to permit favorable layout of the long canals and river channels; and proximity to the Munich headquarters and to as many of the larger hydraulic works as possible. The region just to the south of the Walchensee, a lake some fifty miles from Munich, at the foot of the Bavarian and Tyrolean Alps, was finally selected as fulfilling these requirements to the greatest degree. Actual construction was begun in 1928, and by the spring of 1930 the installation of the basic equipment had been completed and preliminary rating experiments were under way.

Two former assistants of Dr. Thoma's laboratory in the Munich technical university are at present responsible for the activities of the Research Institute: Dr.-Ing. Otto Kirschmer, as Director, and Dipl.-Ing. B. Esterer as Supervisor of Experimentation.

In a laboratory where the models are on a very small scale, an assistant is generally able to take complete charge of a single experiment, and without help carry to completion both the actual handling of the model, once it is built, and the resulting computations. Here at Walchensee the work is on so great a scale that it requires the combined efforts of from three to ten experienced men, and more than one series of experiments is seldom in progress at a given time. Since accuracy depends upon weather conditions, when these are favorable an experiment is carried through to completion without stopping, often requiring uninterrupted work in shifts for from twenty to thirty hours.

An all too prevalent belief is that the Walchensee laboratory is attempting to establish the falsity of the theory of similitude, and the error in this assumption cannot be too highly emphasized. On the contrary, its work proves that this theory is really a dependable tool, once its factors of conversion have been experimentally determined. In the past there has been little opportunity to vindicate the blind reliance on similitude in the accurate study of water flow, where the scale is often reduced a hundred times and more. Until this is clearly illustrated by experiments on the same structures, with models varying from very small to practically full sized, many engineers will continue to mistrust small-model study.

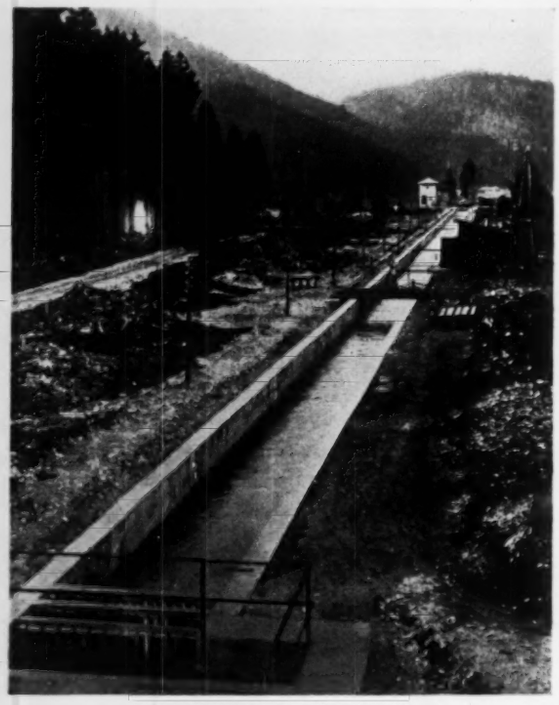
On the other hand, there are demands which only a station of the Walchensee type can meet—perfection of flow-measurement methods for commercial use, tests of canal forms and linings, siphon experiments where the atmospheric conditions cannot easily be reproduced to scale, and other experiments of a like nature. Although other experimenters hold that small-scale indoor equipment provides the greatest accuracy, it is claimed by the leaders of the institute that increasing the size as they do involves little sacrifice of exactitude in measurement, and that this is offset by greater proximity to actual conditions.

THE EXPERIMENT STATION

From its source in the Alps of Tyrol, near Innsbruck, the Isar River flows over the German border and takes a northerly course toward Munich. Just before the village of Krünn, somewhat more than five miles above the Walchensee, the Isar Valley forks, and the river

takes the deeper route to the right so that it passes completely around the eastern side of the Walchensee.

This lake, roughly triangular in shape, $3^1/_2$ miles long and 640 ft. in depth, has a mean surface level 660 ft. higher than that of the Kochelsee, little more than a mile to the north. The Walchensee Power Plant takes complete advantage of this excellent site, and not only draws the entire discharge from the Walchensee, but also diverts the normal Isar discharge of from 15 to 25 cu. m. per sec. (530 to 880 sec-ft.). In winter a minimum of 5 cu. m. per sec. (175 sec-ft.) is reached.



FOURTH SECTION OF THE EXPERIMENTAL CANAL
North from the Titration Scaffold, Salt-Velocity House at Right

This borrowing of water from the Isar is accomplished as follows. At the valley fork near Krünn, as is shown in Fig. 1, a small regulation reservoir has been constructed, so that in dry seasons the total flow of the river may be diverted through a concrete canal and tunnel system into a small pond, the Sachensee, two and one-half miles from the Walchensee, and thence a mile farther through an open-cut channel to the point where the Obernach stream enters the valley. Here the channel ends, and its discharge joins that of the Obernach and flows in its bed to the Walchensee.

Just below this juncture, the Obernach bends away from the highway, circling back parallel to it again at a point half a mile farther downstream. This bend, with the highway on the other side, encloses a flat section of land of about 10 hectares (25 acres), which was chosen by the institute as the most nearly ideal station site in the region. Here is ample space for the development of large-scale layouts and a constant water supply sufficient for all purposes.

Due to a steady fall in the valley, amounting to 66 m. (217 ft.) from the Sachensee to the Walchensee, future expansion of the Bavarian power system calls for a new plant at the southern end of the Walchensee, making use of this head by means of still another diversion canal, with a branch of the institute station at this lower point for turbine and other high-head experiments. In this way the laboratory will have grounds, equipment, and water-supply facilities which, as a whole, will surpass any existing in the world.

STATION LAYOUT

At a point some 60 ft. above the weir, where the Isar diversion channel discharges into the Obernach waters, is the intake canal for the entire laboratory supply, as is shown in Fig. 2. The flow is regulated by two hand- or electrically-driven vertical gates, 3.5 m. (11.5 ft.) in width and rising to a maximum height of 2 m. (6.56 ft.), admitting from 8 to 12 cu. m. per sec. (280 to 425 sec-ft.), depending on the Isar discharge. This water is carried about 350 ft. through the concrete canal parallel to the highway and discharged freely into the concrete stilling basin at the upper end of the supply basin.

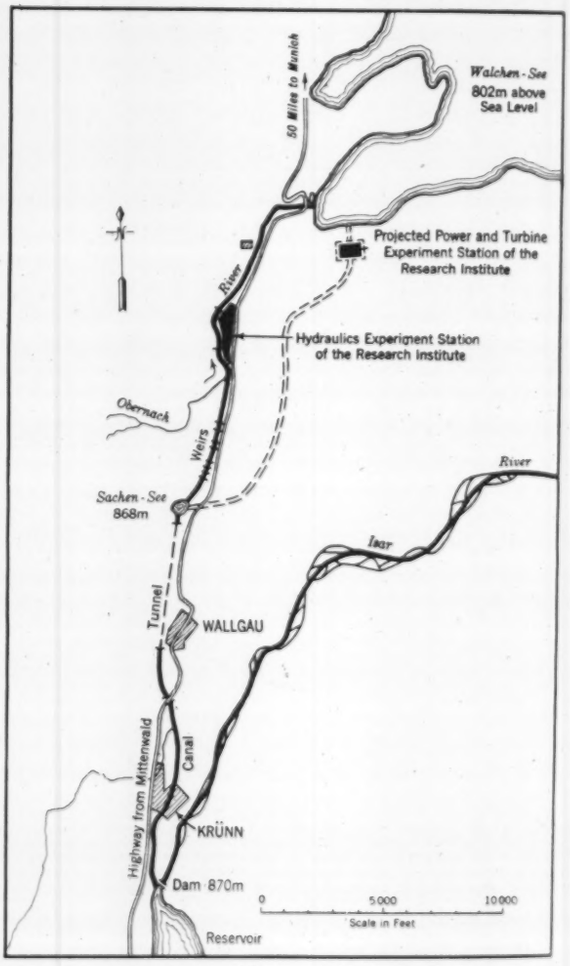


FIG. 1. MAP OF THE KRÜNN-WALCHENSEE REGION
Isar Diversion Canal, Experiment Station, and Turbine Research Station

Since this basin may serve as many as four or five future side channels to separate experiments, it has been given a capacity of 2,500 cu. m. (88,250 cu. ft.), with a 10-m. (32.8-ft.) constant-head weir and a 1-m. drainage gate at the west end, wasting into the Obernach. This basin is unlined, with a side slope of $1:2^1/_2$,

the coarse gravel and clay in the soil withstanding the erosion to a fair degree. The main canal, with a capacity of 4 cu. m. per sec. (141 sec-ft.), runs almost due north from the mid-point of the outer bank of the supply basin for a distance of 575 m. (1,889 ft.).

The first three sections, approximately 280, 475, and 230 ft. in length, respectively, have the same trapezoidal cross section, 9 m. wide at the top, 3 m. at the bottom, and 1.5 m. deep. At first all three were simple earth canals, but the second has since been given a lining of tar-bound gravel of grades varying at intervals throughout its length. The stilling basin at the end of the third earth canal has been made of concrete, extra large to give sufficient energy reduction at the beginning of the fourth section.

It is in this fourth section, which is pictured, that the principal flow researches of the institute have been conducted. Its sides and bottom are of concrete, unfinished except for the stripping of the wooden forms, and are provided at frequent intervals with boarded-in stop-log grooves for temporary bulkheads in the seepage tests, weir insets, and stilling screens. The entire length is provided with numerous standpipes inbedded in the concrete, and with gage pits just outside the channel for the two different systems of water-level observation.

Outflow at the lower end may be measured on a sharp-crested, suppressed weir, adjustable to various elevations. Here the flow discharges into a fore-basin with a capacity of 96 cu. m. (3,390 cu. ft.) below the outlet sills, plus 72 cu. m. (2,543 cu. ft.) with outlets closed. There are two outlets to the fore-basin, symmetrically arranged and controlled by two Tainter gates to turn the discharge into either the waste channel leading back into the Obernach, or into the large measuring basin.

The measuring basin has a usable capacity of 1,500 cu. m. (52,000 cu. ft.), is of finished concrete, and has recently been given a $^1/_4$ to $^3/_8$-in. coat of bituminous waterproofing to eliminate all seepage. Its outlet is into the waste channel through a single vertical gate.

A concrete control house with windows on three sides commands a complete view of the canal and measuring basin. In the basement are transformers reducing the potential of the main supply from 6,000 volts to either 380 volts three-phase, or 220 volts single-phase; convertors to direct current; and storage batteries. On the first floor are other electrical connections, consisting of a switchboard for direct current varying in potential from 2 to 40 volts, an electric clock sending impulses every second to all parts of the station, and a telephone. Here also are the controls for the gates leading from the fore-basin and the measuring basin, the time of movements being recorded chronographically. Instruments for recording current-meter turns and salt velocity curves may be operated here as well.

The entire plant is connected by telephone so that all points are in communication throughout experimentation; and electric lines, the length of the major canal, provide current for both lighting and electrical measuring methods. Since this original canal parallels the main highway, there is ready access to all points by wagon or truck. Bicycles and motorcycles owned by the assistants provide transportation to and from the more distant points without loss of time.

VOLUMETRIC MEASURING BASIN

Claims by the institute directors of an experimental accuracy equal to that of any of the small-scale laboratories have their foundation in the thorough, painstaking planning of each experiment before the run is started; in the use of instruments that are probably among the finest that have ever been developed for this purpose; and in patient, capable analysis and compensation for all unavoidable error. Care and foresight in the arrangement of all the details of layout and procedure have produced an exactitude that is extraordinary in such large-scale work.

Whereas most other laboratories depend for their standard on the mean value of a number of comparative methods of measurement, the Research Institute measures volumetrically the water that passes through its canals during active experimentation with apparatus that is even more accurate than conditions require—a calculated and proved error of ± 0.1 per cent is the maximum that is present.

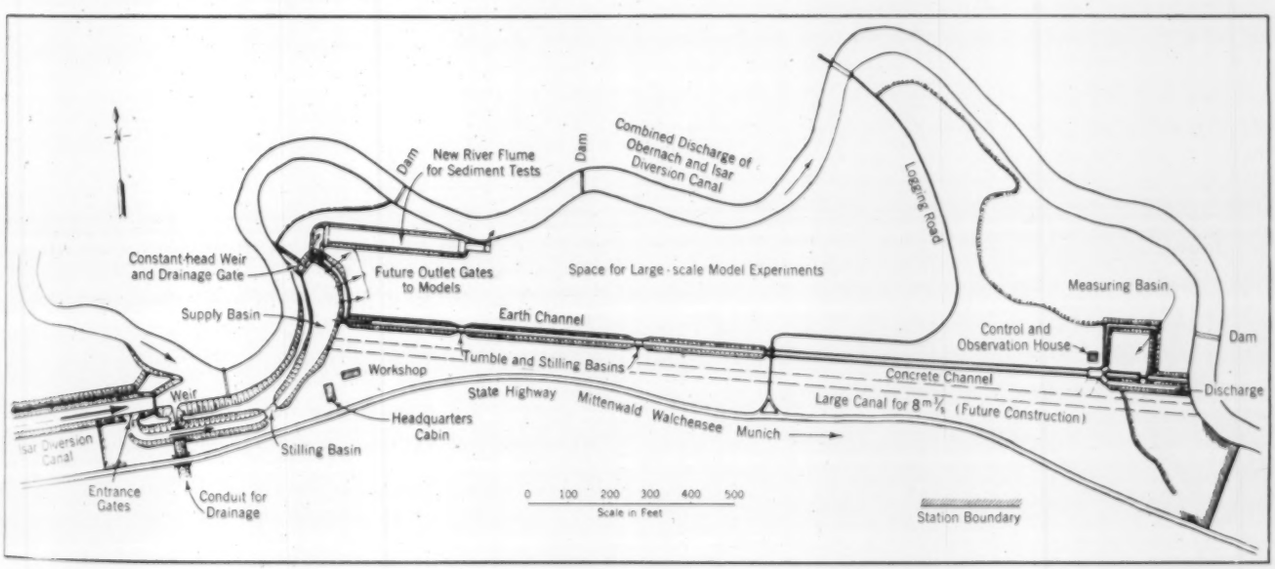
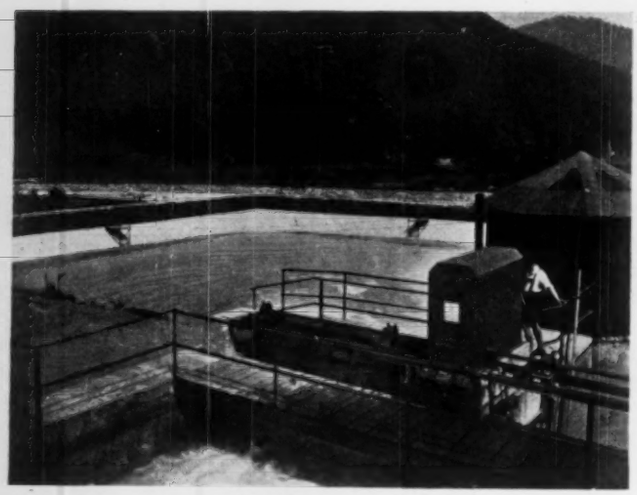


FIG. 2. LAYOUT OF EXPERIMENT STATION, 1930
Research Institute for Hydraulic Engineering and Water Power

Before the measuring basin was used in the first series of experiments, two comparative rating curves were plotted—one from careful measurement and geometrical computation of its capacity with relation to the depth of the water; and the other by actual tabulation of gage readings as quantities of water, measured by weight,



MEASURING BASIN BEING FILLED
Gage House at Right, Fore-Basin in Foreground

READING WATER ELEVATION ELECTRICALLY
Electrode for Salt-Velocity Flow Measurements Also Shown

were successively introduced. Water was pumped from the canal into the balance tank, weighed, and discharged into the fore-basin. Gage readings were made for each different water stand in the fore-basin, and when it was filled to capacity its contents were discharged into the measuring basin and the process repeated until the measuring basin had been rated to depths varying from 0 to 2 m. (6.56 ft.). The balance used has a capacity of 3,000 kg. (6,620 lb.), sensitive to 0.0013 per cent.

Error in recording the actual time of filling the measuring basin has been practically removed by the absolutely symmetrical construction of the fore-basin and the Tainter gates. The two gates are coupled together so that both begin or cease to move at exactly the same instant, one closing at just the same rate that the other opens, and vice versa. Electrical contact is made when each gate reaches or leaves its lowest position, and is recorded automatically in ink on a paper ribbon that contains a simultaneous double chronographic record.

In the gage house for the fore-basin and measuring basin is a remarkably fine set of instruments, arranged to allow the utmost convenience in setting and reading, and so exact in their results that they give an unavoidable error of less than 0.1 mm. (0.00033 ft.). These gages are nine in number, three giving readings for the fore-basin and covering a range of 600 mm. (1.97 ft.), and six for the measuring basin, with a range of 400 mm. (1.31 ft.), overlapping some 3 cm. on the readings of the gage above and of that below.

At various points along the concrete canal are hook gages identical with those at the measuring basin, but located in individual pits beside the canal. The last gage downstream gives readings alternately at the right and left of the weir by a simple valve action.

Type B gage has the same inlet connections, but differs in form and accessibility. Set in the western canal wall are iron standpipes 2 in. in diameter, rising about 4 ft. above the ground. Pointed metal rods of known lengths are inserted in these pipes, insulated from them by wooden balls fitted tightly on the rods but sliding easily through the pipes. Each rod is hooked to a metal scale reading by vernier to 0.1 mm. and lowered until it touches the water surface in the standpipe. Contact is given electrically through a pair of head-phones, current coming from the line along the canal and passing through the circuit formed by the rod and pipe as terminals and the water between as a conducting medium. A sharp buzz is heard the instant the point touches the water.

INITIAL MAJOR EXPERIMENTS AT THE STATION

Simultaneous measurements of flow through the concrete canal by means of the four leading European and American methods composed the first series of studies by the Research Institute. The sharp-crested suppressed weir, the Allen salt-velocity, the chemical or titration, and the current-meter methods of calculation of discharge were all tested for five different rates of flow, all based on the volumetric record taken at the measuring basin several times during each run. By means of these tests the original installation on the station grounds was used to the fullest advantage, and at the same time basic practice was investigated with an accuracy that had never before been attained.

A steel weir crest, of standard form, was bolted to a wooden beam so that it might be raised or lowered in the stop-log groove at the lower end of the concrete canal, the space being boarded in and caulked to water-tightness. Thin boards set into the grooves above the crest preserved the smoothness of the walls and, at the same time, gave free passage of air to the steel ventilation sheet at the downstream side of the crest. An open U-piezometer served as a check on the completeness of ventilation.

ALLEN SALT-VELOCITY METHOD

Apparatus for the injection of a salt solution, according to the Allen salt-velocity method, was located under shelter about 60 m. from the head end of the canal. This

consisted of a 640-liter (22.6-ft.) tank in which a saturated solution was mixed; a 1.2-hp. gasoline pump and compressed-air tank; and a third container in which the solution was held under a 10-atmosphere pressure prior to injection. Injection was made through spring valves on the upstream side of the pipe system.

Electrodes, each consisting of six galvanized iron pipes $^3/_8$ in. in diameter, were set in sockets in the canal bed at four points below the injection apparatus. Each pipe was about 42 cm. (1.4 ft.) from the next, so connected electrically as to give opposing terminals alternately across the section. It is interesting to note that the Allen method was practically unused in Germany until its study by the Research Institute in 1928.

CHEMICAL OR TITRATION METHOD

The principle of flow measurement, through chemical analysis of discharge before and after the introduction of a salt or similar solution, has in the past taken various forms, all apparently highly complicated and requiring considerable time and trouble and the assistance of a trained chemist. The experience of the institute is that, of all four methods tried, titration gives the most accurate results in the shortest time, although handled entirely by a mechanical engineer, and is well adapted to measurements where all other methods are practically impossible.

For the injection of the salt solution at the station, the scaffold and system of tanks illustrated was constructed just above the end of the last earth channel. A saturated solution was mixed in the 2-cu. m. (70.6-cu. ft.) tank on the upper platform, and below the outlet pipe from this tank was placed a constant-head apparatus.

At the beginning of the run, the flow was regulated until conditions became constant. The discharge, 0.5 liters (quarts) per sec., was then directed into the calibrated tank for about 3 min.; next into the injection pipe throughout the run for 20 to 25 min.; and, at the end, back into the calibrated tank. In other words, not only was a practically constant head maintained, but the flow was measured volumetrically twice during the run.

The injection took place just upstream from the large concrete tumble bay, which gave a good mixture of the solution with the canal water. Just below the bay where three wooden stilling screens at the beginning of the concrete canal. Samples were taken at a point about 56 m. (184 ft.) downstream from the injection point by means of a hand pump and a long pipe whose intake can be placed at any point in the channel cross section.

PORTABLE GAGING APPARATUS DESIGNED

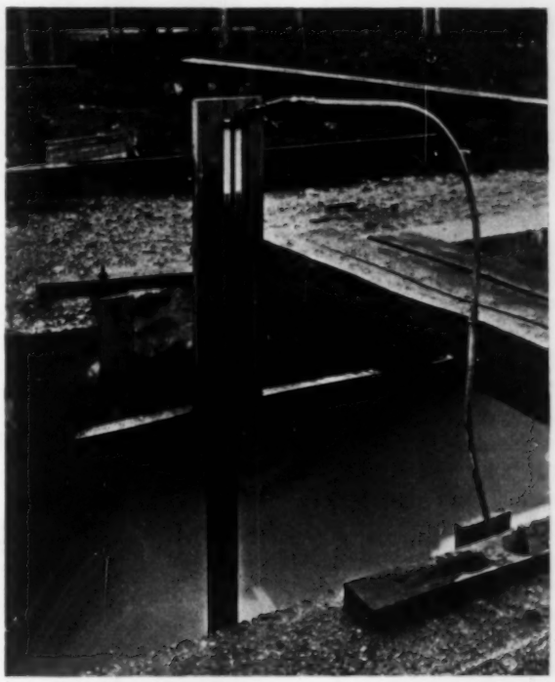
For the purpose of gaging small streams, a portable constant-head discharge apparatus has been devised. The tank is of light steel construction and may be carried easily on a wheelbarrow, the only other materials necessary being the bags of bulk salt, a mixing pail, and the sampling bottles.

This portable apparatus makes the method highly suited to gaging in mountainous country, where current meters are of little value. Several small streams in the Bavarian highlands were rated by the institute to try the method, with such success that two of the assistants spent three months in the fall of 1930 rating streams in the Austrian Alps for the Tauernwerk Power Project.

Mellet's system of chemical analysis has been adopted by the institute for the determination of flow values from the samples taken. It deals only with relative values rather than with an actual quantitative calculation of the salt in each sample. The various solutions are first diluted with distilled water so that all are of approximately equal concentration. Equivalent volumes are evaporated over an electric stove, potassium chromate as an indicator added in equal amounts to each concentrate, and silver nitrate of constant concentration added from a calibrated burette until each solution is brought to exactly the same reddish hue.

CURRENT-METER METHOD

A small wooden bridge with wheel grooves was built across the concrete canal 21 m. (68.9 ft.) upstream from the end weir, to carry the steel meter carriage. The meter was bolted on to a stream-line shaft adjustable

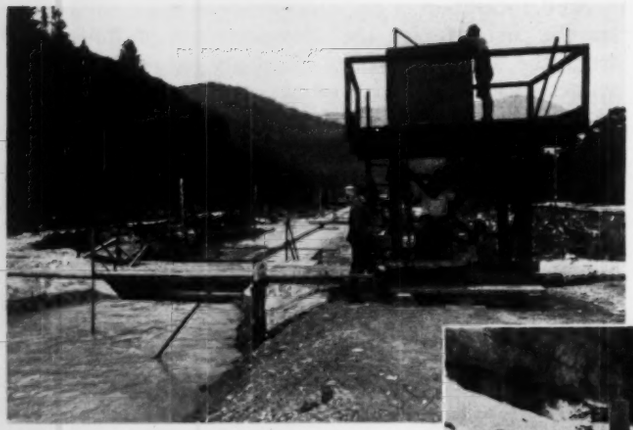


MEASURING DISCHARGE OVER A SHARP-CRESTED WEIR
Piezometer Indicates Degree of Ventilation Under the Sheet

vertically by crank and windlass, so that it might be moved to any point in the canal section.

In these first experiments, efforts were made to compare the action of several different types of meter—a number of vane and propeller Ott instruments, 12 and 18 cm. (4.73 and 7.09 in.) in diameter; and an old-model Price (Gurley 1903), each receiving identical tests. As the Price meter was 28 years old, only the results of the other meters were published. When the current meter was used for the determination of velocity distribution for other methods, that is, for titration and weir, three meters of the same type were used together on the same shaft.

Five different rates of discharge, varying from 0.5 cu. m. to 4.0 cu. m. (17.7 to 141.0 cu. ft. per sec.), were selected for study, the headgate on the canal being set at the beginning of each run to give as nearly as possible



TITRATION INJECTION APPARATUS
Salt Solution Injected Under Constant Head with a Volumetric Check

PORTABLE INJECTION TANK
For Measuring Flow from a Melting Glacier

the discharge determined upon. A period of two hours was allowed for the flow to become constant, after which readings on the various gages throughout the length of the canal and at the measuring weir were begun and continued during the run. The current meters were used first, while the measuring basin was being filled. The salt-velocity method was applied next, immediately following the filling of the basin; and titration completed the sequence. This procedure was carried through three times for each run.

In the event of rain, the run was stopped and continued as soon as the weather permitted. At the termination of each run the results of the weir discharge and the measuring basin records were rapidly computed, so that, in case of appreciable error, the run might be immediately repeated under the same flow conditions. Approximately a month was required for the five runs. All data were then taken to the Munich offices, where the calculation of the results was carried out by a staff of six assistants during a period of about six weeks.

RESULTS OF INITIAL EXPERIMENTS

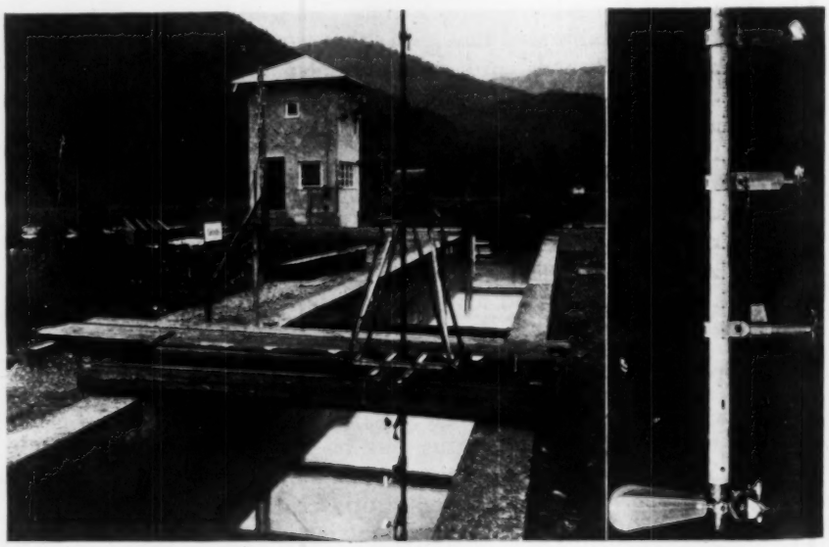
Accuracy of weir measurements depends on two inter-related qualities—the existence of uniform flow conditions with a weir of standard dimensions, in good condition; and the use of a reliable formula for discharge computation.

Since the four accepted formulas were derived from experiments conducted in laboratories to scale, the outcome of the institute tests seems to substantiate the doubt that exists with regard to the use of the sharp-crested weir formulas for large discharge, calling obviously for considerable research with the weir at full scale under greater heads than those which have so far been investigated.

Both Ott "Texas" meters gave excellent results, each rating slightly under the actual discharge. The Price meter's average error of 1.845 per cent greater than actual discharge was at first attributed to the comparatively small cross section of the canal, but a larger Ott meter showed an average error of only −0.378 per cent. It is, of course, pointless to base comparison on the action of a meter 28 years old, in however good a condition it may be. The negative errors of 0.3 per cent and 0.6 per cent are a proof of the accuracy of the Ott instruments. Nevertheless, accuracy depends on the rating of the meter prior to use, since it is only after careful and dependable rating that a meter can be so reliable.

In the salt-velocity method, nearly all values were lower than the actual discharge, and a great number of individual tests was necessary before the average reduced the error to a satisfactory point. The error of this method, 1.2 per cent, was the greatest of all three. A further drawback to its practical use is the impossibility of determining before hand the most favorable location of the electrodes. Experience in penstock tests at the Walchensee Power Plant led to the same conclusion.

Most consistently accurate of all was the titration method, the departure being almost equally distributed above and below the measuring basin data, and giving average errors of only +0.03 per cent and +0.06 per cent, respectively, for a mean of all points in the canal cross section and a weighting of each sample to the existing velocity at that point. Since the current meter is suitable only for uniform flow conditions and the titration method depends on turbulence for satisfactory mixing of the concentrated salt solution with the discharge, the two methods cover well the field of stream gaging.



BRIDGE AND CARRIAGE FOR CURRENT-METER MEASUREMENTS
Near View of Rod Supporting Current Meters

Other tests are under way or have been completed, among them those on canal flow, on the measurement of power-plant penstock discharge, on a model spillway crest, and on the deposit of sediment by the Isar River.

Marine Oil Well Construction

Special Foundations and Platforms Required for Drilling in Submarine Oil Fields

By T. Farrance Davey

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California oil fields have been found to extend out under the Pacific Ocean. In the Santa Barbara Channel extensive drilling operations have continued for a number of years, and as the field becomes one of proved value, and wells are carried to greater depths, more permanent and substantial derrick foundations will be required. A number of types of construction, which have been built either in the pounding surf or farther offshore at depths of water up to 100 ft., are here described and their construction explained. The application of the caisson type of foundation to oil-field construction is new.

In the usual oil field on dry land, derricks are supported at the four corners on pyramidal concrete footings. In designing these footings, consideration must be given to the type of soil, the dead weight of the derrick and the pipe which may be stacked up in it, the overturning moment imposed by the wind load, the direct pull of the hoisting cable, and the reaction at the hoist end.

The floor of the derrick carries the rotary table and the pipe stack. It is supported by struts that extend directly to mudsills on the soil, the struts being made of timber or, preferably, of steel or concrete to resist fire. Where the derrick is built on the side of a hill, these footings may vary in height, or they may be brought to grade by building on top of them a steel superstructure of braced H- or I-section columns. The area directly under the rotary table and surrounding the casing is enclosed to form a drainage sump and operating chamber for assembling valves and fittings while drilling is in progress. It is called the cellar.

Protection against wave action

Recent explorations for oil under oceans and lakes have led to the adaptation of such structures as are used for lighthouses and bridges to the services of the oil field for the foundations of oil derricks. Higher and deeper foundations are necessary, and these accentuate overturning moments and present a considerable surface to the waves, a new factor, the effects of which vary considerably with the locality. The chief destructive effects encountered from this source are wave impact and uplift, erosion, sand scour, and corrosion.

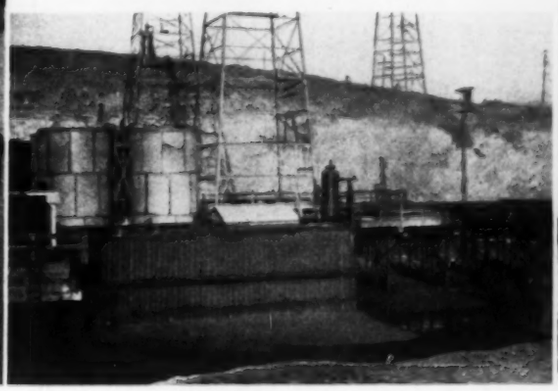
Waves of the purely oscillatory type, that is, very deep ocean waves, will not be encountered because of the economic limit to the depth of water in which derrick structures can be built. Such wave lengths range from 150 to 3,000 ft., the wave base being approximately an equal number of feet in depth. At the wave base, the orbital motion of the water particles is zero. However, at water depths less than the depth of the wave base, the friction of the bottom retards the motion of the wave particles, and a higher wave or shorter length results. Thus the wave ultimately begins to turn over in a cusp or breaker, and becomes a translatory wave with a velocity approximately equal to

$$V = \sqrt{\frac{g(H+h)}{1+\left(\frac{H}{H+h}\right)}}$$

where $g = 32.17$ ft. per sec.; H = depth of water below trough of wave in feet; and h = height of wave in feet.

The worst conditions of wave impact are caused by a wind of maximum velocity approaching the shore along a maximum length of fetch, coincident with a falling

Birdseye View



Storage Facilities

In Operation

Cofferdam Type of Foundation for Beach Line

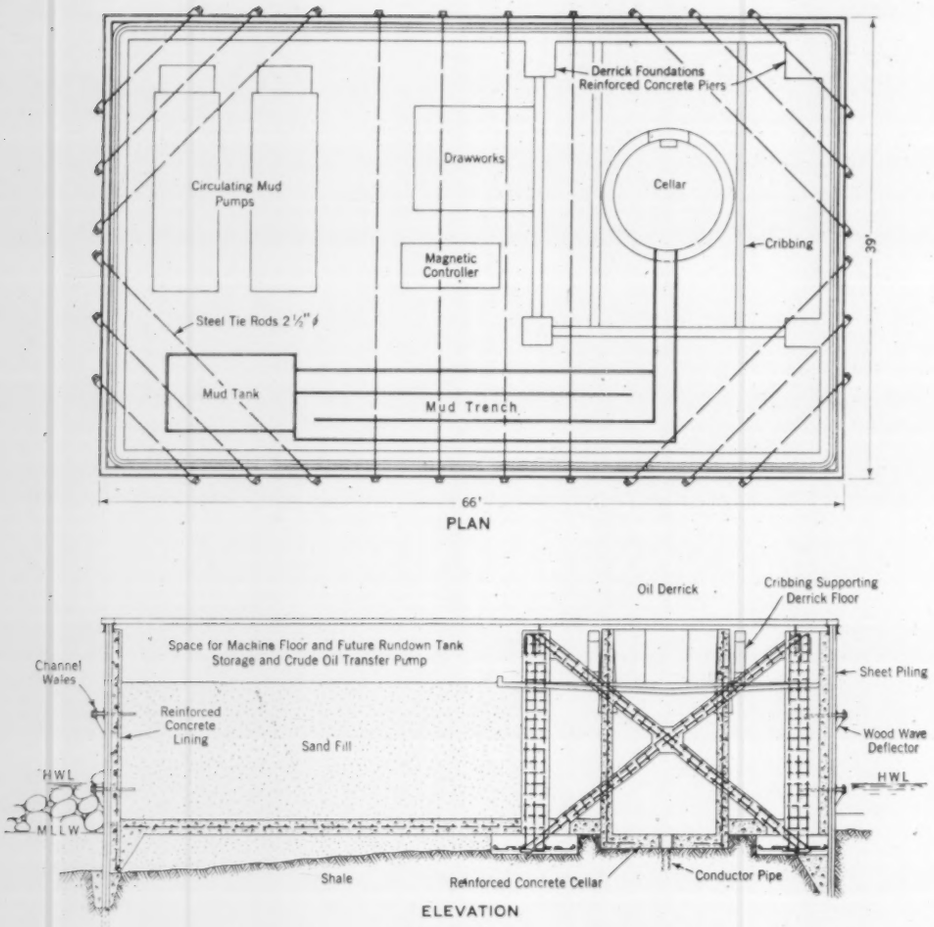


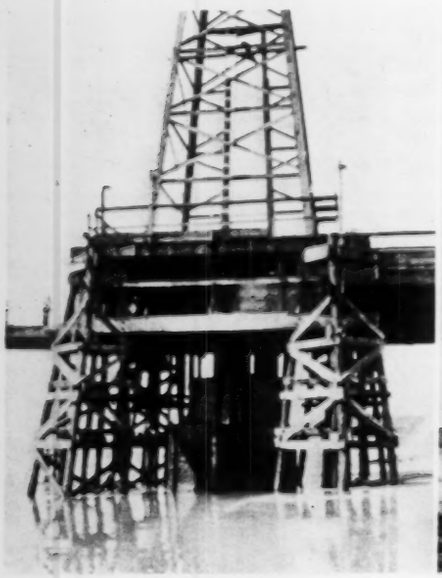
FIG. 1. MARINE OIL-WELL FOUNDATION ON BEACH
Storage Facilities Inside of Cofferdam

barometer and a period of high tide. It has been estimated that the tide itself is increased in height by approximately 13 in. for a drop of 1 in. of mercury and, on the Pacific Coast, it may be expected that a water current with a velocity of about 2 per cent that of the wind, flowing in a direction of about 20 deg. to the right of the wind in the Northern Hemisphere, will be set up. Local conditions on the coast line will deflect this current more or less from 0 to 53 deg.

WAVE PRESSURE

Under these conditions, a fetch of 30 miles, a wind velocity of 50 miles an hour, a higher high tide, and a falling barometer will increase a mean high tide of 5 ft. to 12 ft., with breakers 12 ft. high and a velocity of 28 ft. per sec. Assuming that such breakers traveling at their maximum velocity reach exposed surfaces, a normal pressure of 1,500 lb. per sq. ft. may be expected on a plane surface, and spray will be thrown 20 to 30 ft. in the air. Although these conditions are exceptional and abnormal, they may be expected on rare occasions. At the same time offshore conditions will be less severe, with lower waves which are more oscillatory in action, the horizontal movements of the particles being reduced approximately in geometrical progression as the depth increases in arithmetical progression.

The rigid structure necessary to withstand this force will naturally have such a short period of vibration that the comparatively long period of the waves, up to



Wood-Pile Supports

Small Validating Oil Well

Well in a Shallow Field

CONSTRUCTION IN TEMPORARY AND SHALLOW FIELDS

2 sec., will have little effect on the foundation. If, due to poor foundations, the structure is unstable, vibrations and impact may be transmitted to the derrick itself and, under certain conditions of loading, it may vibrate sympathetically with destructive effect on the foundation.

Torsional loading from the rotary table will occur during drilling, but under normal conditions it will be absorbed by the foundation and the surrounding structure. Due to vibration in drilling, the possibility of earthquake shock, and the highly concentrated loads carried by the deck, reliance should not be placed entirely on reinforced concrete, but on structural steel beams and columns embedded in it. Fireproof supports should be provided under the derrick floor because, in the event of fire, the loads on the floor would otherwise buckle the floor beams, pulling in the four legs of the derrick and damaging the foundation.

A VARIETY OF SUPPORTING STRUCTURES IN USE

In inland seas and lakes and in protected ocean locations where heavy seas are not encountered, the derrick can be built on wood piles treated with a suitable preservative. Four or five piles at each corner, lattice-braced together, form a suitable foundation, the cellar being made of sheet piling. A comparatively soft bottom is an economic necessity for this type of structure. In more exposed locations, such a foundation may be inclosed in a sand-filled sheet-pile bulkhead.

Above low water, close to shore and on a rock bottom, concrete piers can be built to a suitable height and protected from excessive wave action by works, such as two rows of piles parallel to the shore and closely interwoven with second-hand drill cable. For validating wells on marine leases, which are situated in a field of doubtful value, small derricks are built on a deck supported by second-hand drill pipe driven into the shale, if such a formation, which is prevalent on these leases, is encountered. A small pier is then built to accommodate a portable cable tool rig with which to drill the hole.

Where accommodations for equipment and oil run-down tanks cannot be obtained on land, provision for them must be made on the derrick foundation, with a suitable fire wall to safeguard neighboring structures and, in case of oil-tank leakage, to protect the sea from pollution. Such a structure is shown in detail in Fig. 1.

In very shallow water a steel sheet-pile cofferdam, about 66 ft. by 39 ft., is most suitable for this purpose, the seams being caulked at low tide with oakum and quick-setting cement. Excavation can then be made below the sand level to bedrock, on which is built the derrick foundation, consisting of four reinforced concrete piers suitably braced and bonded into the concrete lining of the cofferdam. The cofferdam also retains the interior sand fill against the suction of the waves.

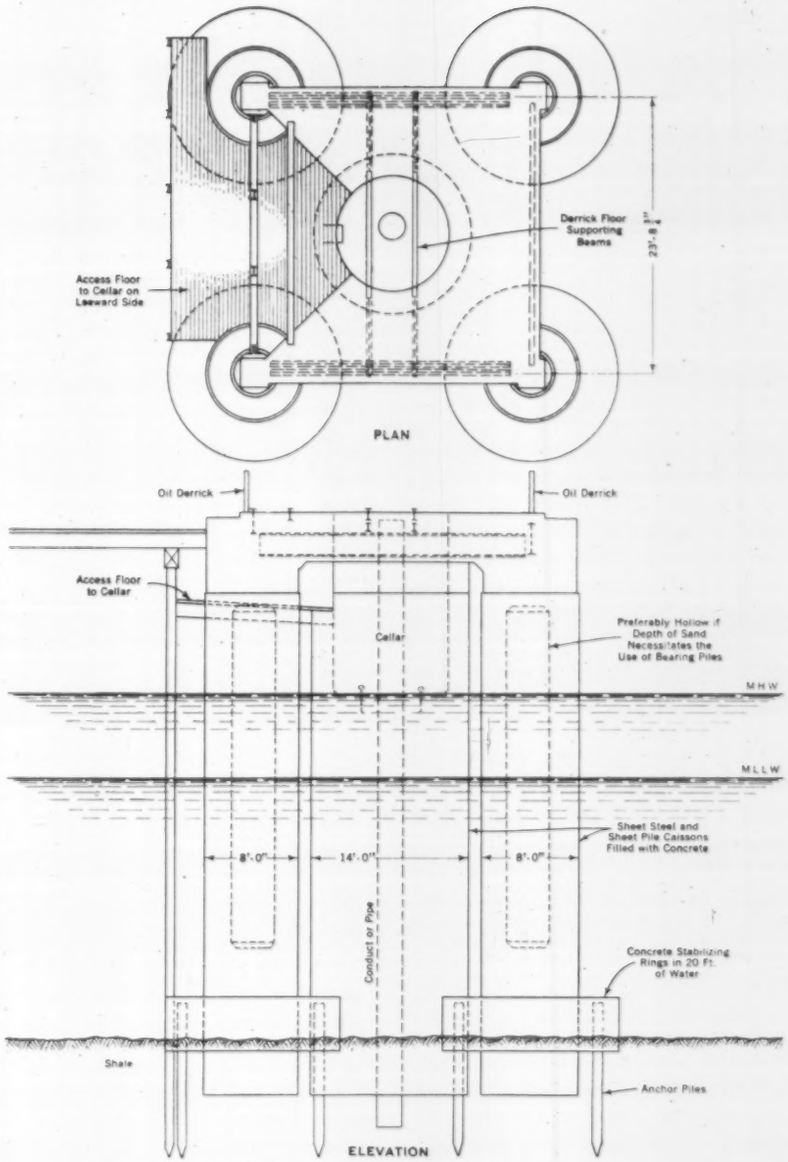


FIG. 2. MONOLITHIC FIVE-LEG FOUNDATION OF REINFORCED CONCRETE Suitable for the Breaker Line

Its rectangular shape is maintained by exterior channel wales of structural steel tied together through the cofferdam by tie rods, $2^1/_2$ in. in diameter, across the corners and through the width of the structure. A concrete lining is bonded to the sheet piling by light reinforcement, which passes through steel loops welded to the sheet piling. The structure thus serves as a foundation for the derrick and provides sufficient space for mud pumps, trenches, a mud tank, and the engines of the rotary-rig drive during the process of drilling. When the well begins to produce, this space is used for four run-down tanks and a crude-oil transfer pump house from which oil can be pumped to storage. The surrounding concrete-lined cofferdam makes an efficient fire wall.

For use in moderate depths of water and on beaches

Sinking the Caissons | Ready for the Derrick | Modified Type in Sheltered Situation

FIVE-LEG TYPE OF FOUNDATION

subject to severe pounding from the breakers, a "five-leg" type of foundation is most suitable if storage facilities can be provided on shore. Caissons, built of interlocking sheet piling driven into the shale, or sheet-steel cylinders sunk by excavating inside with jets or buckets and then applying superimposed loads, are tremied full of concrete, as shown in detail in Fig. 2. Reinforcing steel or steel piles driven inside the caissons provide, through a heavy reinforced-concrete deck, a means of bonding the four legs and the cellar together into a monolith. The deck is not only reinforced, but steel beams are embedded in it to carry the highly concentrated loads imposed.

Vibration of the structure is by this means minimized, and resistance is provided to any wave uplift that may occur below the deck. Access to the cellar is obtained from the sheltered side of the structure. Drilling equipment is accommodated on an adjacent pier consisting of timber decking, joints, and caps on steel piles, stiffened by welded-steel cross braces and horizontal girts. A pipe rack and approach to the derrick for the heaviest of highway loadings is similarly provided.

In protected situations, a more commodious working space is obtained under the derrick floor by using a truss system in place of the concrete floor. The bottom chords support the operating floor below the rotary table, while the top chords support the derrick floor proper. Unless this system is very rigid and properly cross braced, it is not suitable for exposed situations.

The height of the structure above the water line depends on the predictable local weather conditions. Steel piling must be heavy enough to withstand the superimposed load with due allowance for corrosion during the life of the field. Under marine conditions it is usually better economy to make expenditures on a heavier pile section than on protective coatings for the metals. Some defect has usually developed in the material itself or in its application to the pile, while the coating is sure to suffer damage in the processes of construction or by sand scour.

In deeper water, up to 20 ft., a stabilizing ring of tremied concrete should be cast on the ocean floor surrounding each of the outer legs. Anchor piles are first driven with a follower into the shale concentrically around the base of these legs, and the piles are then

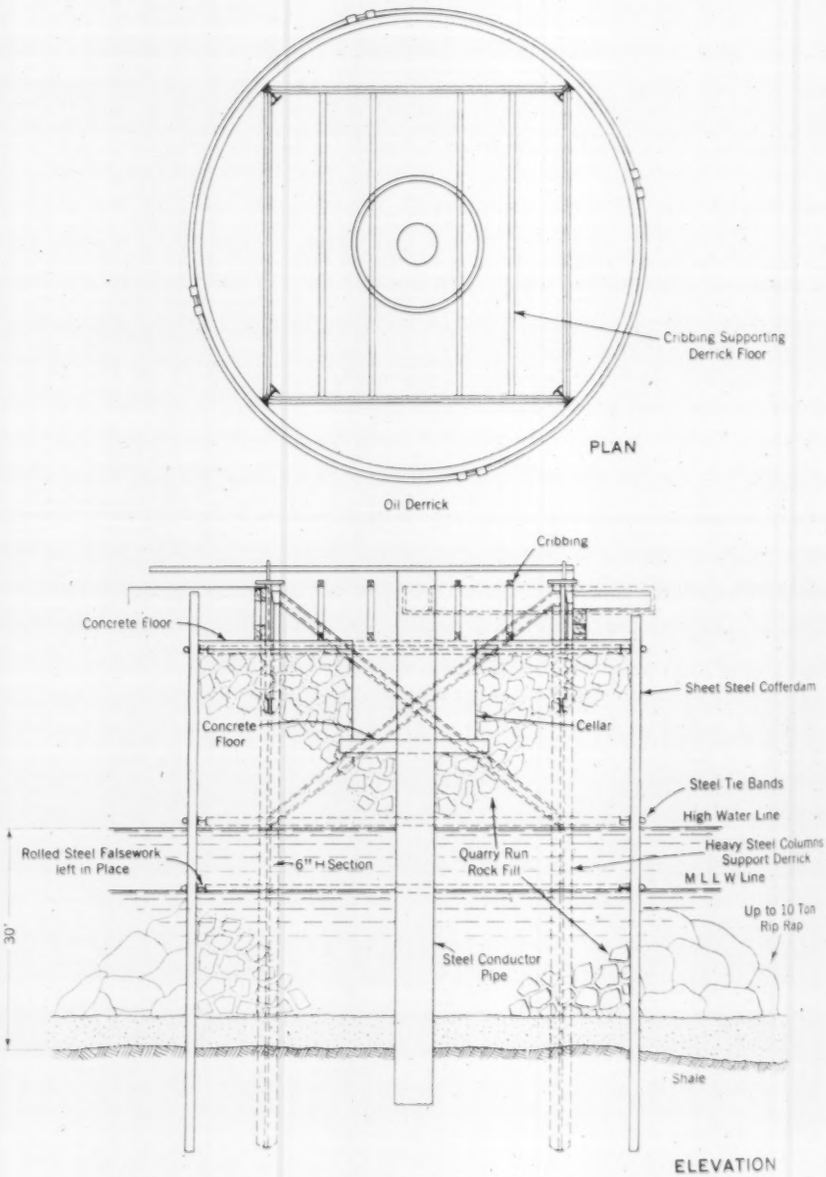
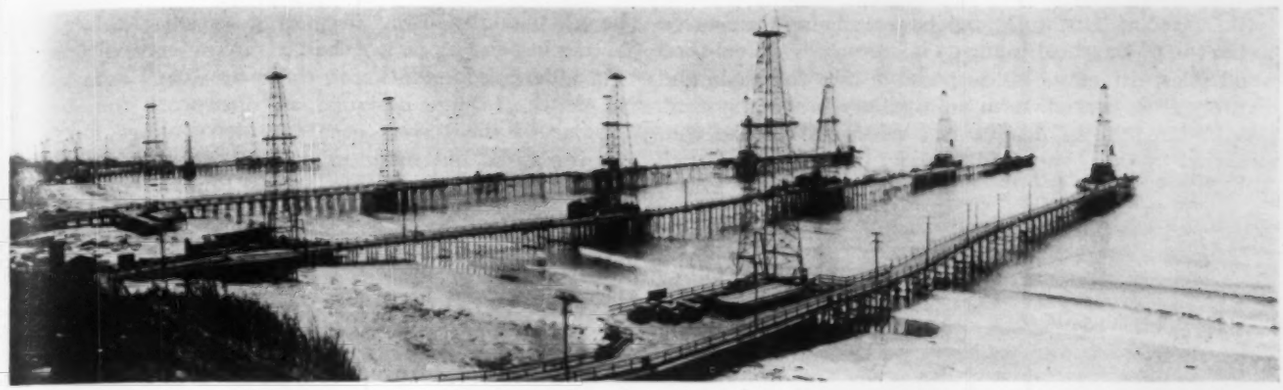


FIG. 3. SINGLE 36-FT. CIRCULAR ROCK-FILLED COFFERDAM TYPE
A Depth of Water Over 30 Ft. Requires Arch Web Section Sheet Piling



SUBMARINE OIL FIELD, SANTA BARBARA CHANNEL
Left to Right, Barnsdall Oil Company, Pacific Western Oil Company, and the Elwood Oil Field

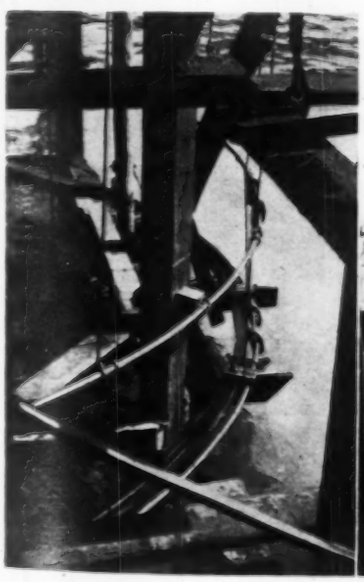
enclosed in a sheet-steel caisson of approximately double the diameter of the leg caisson. The circular ring between the two caissons is jetted or dredged as clear as possible of sand, and then filled with tremied concrete, 4 or 5 ft. deep, to add stability to the structure and prevent erosion of the sand. If the depth of sand over the shale is too great, bearing piles may be driven to support each caisson, in which case it is preferable to cast the concrete in the caisson around a central core form for a part of the depth, to lighten the structure.

CIRCULAR ROCK-FILLED COFFERDAM
Derrick in Place

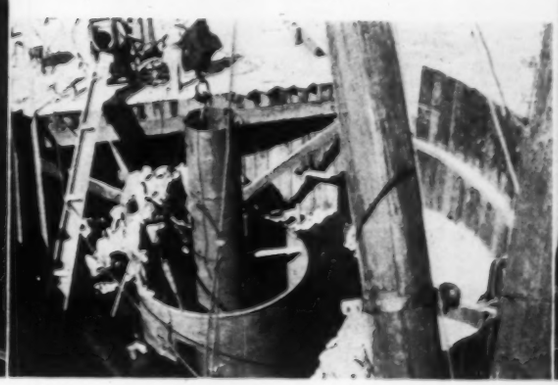
SINGLE ROCK-FILLED COFFERDAM CONSTRUCTION

In deeper water, a more economical design can be used, consisting of a sheet-pile cofferdam 36 ft. in diameter. For depths up to 30 ft., below lower low water, the interlocking sheet piles of straight web section must be designed so that they will take the bursting stresses of the quarry-run fill inside, as is shown in Fig. 3. Four heavy steel columns are driven into the shale to support the four legs of the derrick. On these is built up the falsework necessary for placing the sheet piles. This falsework has to be substantial to hold the piles in position against swells and breakers, until they are all in place, a closure is effected, and they are driven to a bearing in the shale. The final closure is made by means of screw clamps inserted in holes cut in the sheet piles adjacent to the gap. Prior to the closure, only half a dozen piles are driven and these diametrically opposite to the point of closure.

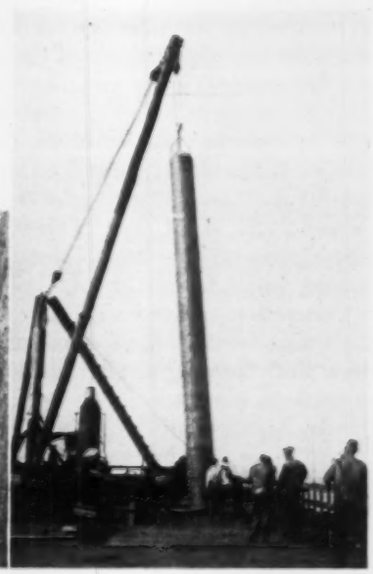
After closure is effected, the remaining piles are driven to bearing. The falsework for the 30-ft. depth, illustrated in the photograph, consists of two sets of 12 by 12-in. cribbing between the steel-pile supports for the derrick. To these supports are welded circular falsework rings, 35 ft. in diameter, rolled from 6-in. H-sections. The lower ring of three, which has to be sunk under water, is fastened to the piles by steel clips, the whole ring sliding down the flanges of the steel piles. Outside tie rods are necessary to hold the sheet piles together during construction and they remain in place to strengthen the lower part of the sheet piling. These, four in number, are fastened by bent rod hangers



Guides for Placing Sheet Piles



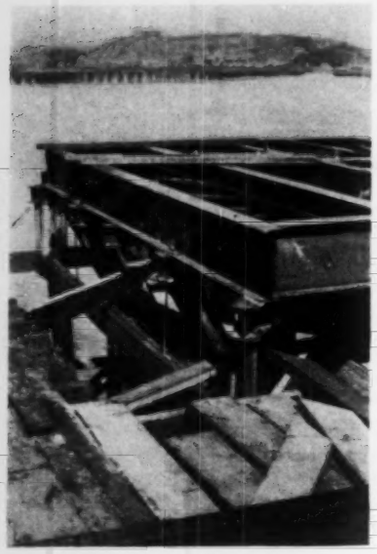
Sheet Piling, Cellar, and Conductor Pipe
CIRCULAR ROCK-FILLED COFFERDAM



Setting the Conductor Pipe

to the circular falsework, the hangers being transferred to the top of the sheet piling as it is erected. Steel-shod wood piles, driven as far as possible into the shale and securely cross braced, form an auxiliary bracing system.

A 20-ton stiff-leg derrick is a necessity for the construction of this type, and it should be equipped with a 60-ft. boom and a 4-drum hoist. After the cofferdam is completely erected and driven, and the conductor pipe for the drilling mud is securely driven into the shale until watertight, the cofferdam is filled with quarry-run rock and a steel cellar is installed and filled around with rock. The structure is completed by placing rock riprap around the outside to prevent sand scour and erosion. During the process of construction, the derrick pile foundations are secured in place by heavy steel channel cross braces welded to the piles and left in position with the 6-in. steel falsework.



SINGLE-LEG CONCRETE-FILLED TYPE
Steel Frame for Deck and Supporting Brackets

SINGLE CONCRETE-FILLED COFFERDAM

An alternative cylinder foundation has been developed by L. B. Collins, of the Barnsdall Oil Company, and a patent was applied for in June 1930. It is designed on the same principle, but requires a somewhat longer time for construction, and involves the filling of the inside of the cofferdam with concrete and replacing the rock riprap with a stabilizing ring of tremied concrete inside a steel form, as indicated in Fig. 4. By bracketing out from the pile supports of the derrick, these supports can be spaced closer, enabling the surrounding cofferdam to be made smaller, or about 18 ft. in diameter. The decrease in stability of the caisson, by reason of its smaller diameter, is offset by the tremied concrete ring outside it. Some 30 steel piles are driven inside the inner caisson to anchor it, four of these carrying steel brackets which support the 24-in. steel I-beam frame, 24 ft. square, which forms the foundation for the derrick base.

Concrete is tremied until it reaches a point above sea level and is then poured to encase the columns and deck steel, forming a cellar inside a concrete pillar 18 ft. in outside diameter. The deck is cut out, as in the five-leg type already described, to provide access to the cellar. Due to this gap in the deck, a steel I-beam cross brace is welded between the corner columns as a temporary support while the concrete in the deck is setting, being later cut out for the conductor pipe. The whole structure is electrically welded together.

Both of the types just described are suitable for greatly increased depths. The rock-filled cofferdam can be modified by using deep arch-section sheet piling, acting in bending rather than in circumferential tension. For a derrick foundation in water up to and over 100 ft. in depth, I have designed an open-work foundation, similar to the towers used for high voltage electrical transmission, but made in unit sections for convenient erection from the surface. This type is considerably cheaper than any of those so far mentioned.

Except for the rock-filled cofferdam and the single-pillar concrete type, which is an adaptation of the five-leg type, I have been largely responsible for the design of the types described. The four types have been used successfully by Merritt—Chapman and Scott, Contractors, for the Barnsdall, the Rio Grande, and the Italo

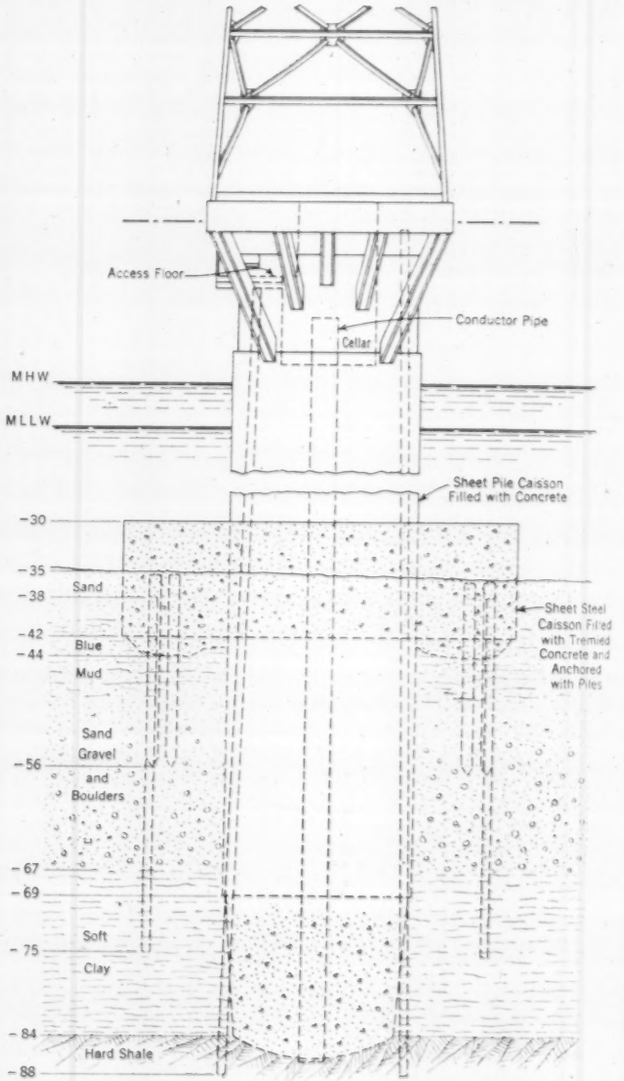


FIG. 4. SINGLE 18-FT. CIRCULAR CONCRETE-FILLED COFFERDAM TYPE

Petroleum oil companies; and by Quinton, Code and Hill—Leeds and Barnard, Engineers/Consolidated, for the Bankline Oil Company, and the Oakburn Drilling Company, all situated in the Santa Barbara Channel off the Pacific Coast. I was also Resident Engineer on the last mentioned construction.

Researches in Concrete Aid the Engineer

Developments in the Use and Testing of Plain and Reinforced Concrete

By H. F. GONNERMAN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
MANAGER, RESEARCH LABORATORY, PORTLAND CEMENT ASSOCIATION, CHICAGO

WITH over sixty listed agencies now at work investigating cements and concrete aggregates, conducting tests on plain and reinforced concrete, and studying the design and placing of concrete mixtures, our knowledge of this important material has greatly increased. Since reinforced concrete first began to be generally used, at the beginning of the century, and especially during the last five years, methods have changed with rapidity. Tests now being made are pointing the way to even newer and more efficient methods than those now generally accepted. The author has based this article on a lecture which was given by him before the Society for the Promotion of Engineering Education, at Yale University, on July 15, 1930.

WHEN E. Coignet, a French engineer, first proposed a method of reinforced concrete construction seventy years ago, he was just as much a pioneer as Captain Cugnot who, in 1769, built the first steam-propelled road vehicle. Even though earlier inventors had worked with steam, Cugnot started at the beginning. Portland cement was invented in 1824 and reinforcing was probably used prior to 1855, yet Coignet had very little helpful information from others to guide him when he made his contribution to reinforced concrete construction in 1861.

The first important investigations on reinforced concrete were made from 1870 to 1880 by Thaddeus Hyatt, an American engineer, who carried out experiments in the laboratory of Kirkaldy, London, England. The work of Hyatt, no doubt, stimulated other writers and investigators to undertake researches on plain and reinforced concrete, and during the years from 1880 to 1900 important contributions to our knowledge of the subject were made by Feret, Considere, Monier, Hennebigue, Christophe, Bauschinger, Tetmajer, Bach, Martens, Morsch, and others.

The period from 1900 to 1914 was particularly productive of tests on reinforced concrete both in this and foreign countries. During this time such well known American investigators as Talbot, Hatt, Humphrey, Turneaure and Withey reported numerous researches but the properties of plain concrete were given relatively little attention. As a consequence, far more information was actually available on reinforced than on plain concrete. As is frequently the case when new materials are developed, the use of concrete had outstripped the knowledge of its properties.

PRINCIPAL AGENCIES ENGAGED IN RESEARCH

About 1914, the increased use of concrete for roads and pavements revealed the need for more accurate and comprehensive information on the properties of plain concrete, and caused various interested agencies to inaugurate extensive research programs. There are now many different agencies engaged in studies of concrete and related materials, some of which are listed here.

This partial list of agencies engaged in concrete researches has been compiled from information collected by the American Concrete Institute's Committee 101 on Survey of Research in Progress. Besides the numerous agencies named, there are others that have important research programs under way.

In the application of concrete to the various fields of construction, new problems are constantly arising which require systematic and accurate investigations to obtain the information necessary for their solution. Manufacturers and producers of concrete materials were among the first to realize the necessity for, and the advantages of, cooperative research. These and related industries, such as machinery manufacturers, have extensive research programs under way.

SOME AGENCIES PUBLISHING INVESTIGATIONS ON CONCRETE AND RELATED MATERIALS

NATIONAL TECHNICAL AND SCIENTIFIC ORGANIZATIONS

American Concrete Institute
American Society for Testing Materials
American Society of Civil Engineers
The Engineering Foundation, Inc.
National Research Council, Highway Research Board

GOVERNMENT BUREAUS, MUNICIPALITIES, AND INDUSTRIAL ORGANIZATIONS

National Bureau of Standards
U.S. Bureau of Public Roads
U.S. Navy Department, Bureau of Yards and Docks
New York Board of Water Supply
Hydro-Electric Power Commission of Ontario
Aluminum Company of America

STATE HIGHWAY COMMISSIONS AND DEPARTMENTS OF:

California
Georgia
Illinois
Minnesota
Michigan
Iowa
New Hampshire
Pennsylvania
Tennessee

NATIONAL TRADE ASSOCIATIONS

Portland Cement Association
Portland Cement Association Fellowship at National Bureau of Standards
National Crushed Stone Association
National Sand and Gravel Association
National Slag Association

FOREIGN ORGANIZATIONS

Vienna, Laboratorium der tech-Hochschule
Ghent, University of
Brussels, Travaux Publics de Belgique
Brazil, Polytechnic Institute of Sao Paulo
Copenhagen, University of
England, Department of Scientific and Industrial Research
Laboratoire des Ponts et Chaussees, France
Sorbonne University, France
Stuttgart, Technische Hochschule
Karlsruhe, Technische Hochschule
German Portland Cement Manufacturers Laboratories
Staatlichen Materialprüfungsamt zu Berlin
Touring Club Italiano
Kyoto Imperial University, Japan
Kyusha Imperial University, Japan
Tek, Tidskrift, Sweden
Federal Laboratory, Switzerland

UNIVERSITIES AND COLLEGES

California, University of
Colorado, University of
Columbia, University of
Illinois, University of
Iowa State College
Kansas State Agricultural College
Lehigh, University of
Louisiana State University
Maine, University of
Maryland, University of
Michigan, University of
Michigan State College of Agriculture
Minnesota, University of
Northwestern University
Ohio State University
Purdue, University of
Saskatchewan, University of Saskatoon
Texas, University of
Washington, University of
Wisconsin, University of

PORTLAND CEMENT ASSOCIATION ACTIVITIES

Investigations on plain concrete by the Portland Cement Association were inaugurated on a comprehensive scale in September 1916, at the Structural Materials Research Laboratory, Lewis Institute, Chicago.

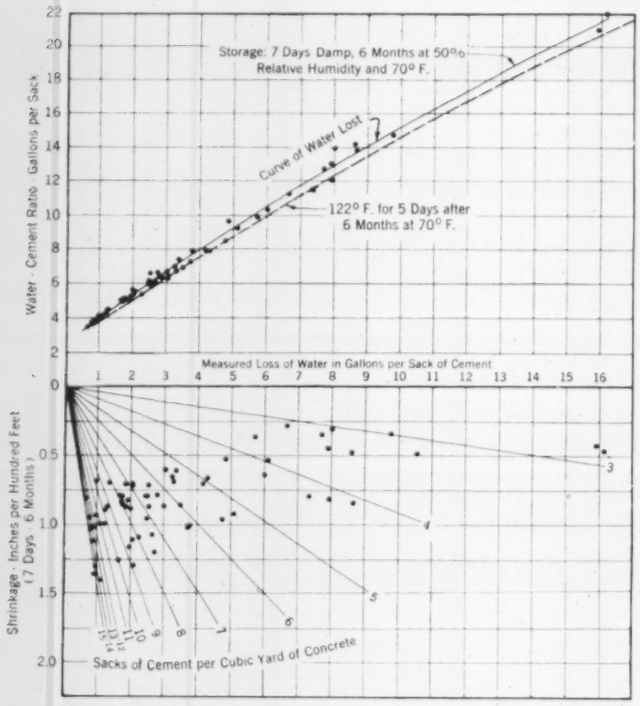

Storage: 7 Days Damp, 6 Months at 50% Relative Humidity and 70° F.
Curve of Water Lost
122° F. for 5 Days after 6 Months at 70° F.
Water - Cement Ratio Gallons per Sack
Measured Loss of Water in Gallons per Sack of Cement
Shrinkage - Inches per Hundred Feet (7 Days - 6 Months)
Sacks of Cement per Cubic Yard of Concrete

FIG. 1. INTERRELATION OF SHRINKAGE, LOSS IN WEIGHT, CEMENT CONTENT, AND WATER–CEMENT RATIO

To estimate probable shrinkage follow a vertical line from a point on the curve in the upper diagram, corresponding to a given water–cement ratio, to the intersection with a radiating line corresponding to the proper number of sacks per cubic yard in the lower diagram. The shrinkage is then read directly from the scale at the left.

These investigations were carried out through a cooperative arrangement between the institute and the association and constituted one of the first instances of continuous cooperative research by an industry and an educational institution in the United States. The purpose of this research program was to learn the basic facts regarding the properties of concrete and concrete manufacture, and to make these facts available to the engineering profession so that methods of making concrete might be constantly improved.

On June 30, 1926, the cooperative agreement with the Lewis Institute was terminated when the association established its research laboratory in the Portland Cement Association Building, Chicago. There the investigations begun at the Structural Materials Research Laboratory were continued along the same lines as formerly, and with the same staff.

SCOPE OF RESEARCH ACTIVITIES

Thus far the researches have been confined largely to plain concrete and aggregates. In addition, investigations, on portland cement are being carried out by the Portland Cement Association Fellowship at the National Bureau of Standards, Washington, D.C.

To date, the principal problems have had to do with the development of the process of making concrete. As methods were not standardized, much of the early work consisted in developing a proper testing technic. The scope of these first investigations is indicated by the following partial list of subjects studied:

Effect of water content on the properties of concrete
Proportioning and mixing concrete
Curing of concrete
Wear tests on concrete
Effect of vibration and pressure on the strength of concrete
Modulus of elasticity of concrete
Effect of tannic acid on the strength of concrete
Effect of powdered admixtures
Flexural strength of concrete
Tests of impure waters for mixing concrete
Use of calcium chloride as an admixture and as a curing agent
Tests of bond between concrete and steel
Time of mixing
Methods of testing concrete and concrete materials

Results of these and later studies have been reported in bulletins, in papers before technical and engineering societies, and in engineering magazines. Many unpublished data have been made available to committees of technical societies for use in developing standards and test methods, and in fixing specification requirements.

STUDY OF VOLUME CHANGE

Current researches deal principally with fundamental problems relating to durability and other properties of concrete. Among the outstanding investigations now in progress is a study of the shrinkage and expansion of concrete, which are recognized as important factors in the behavior of plain and reinforced concrete structures. Observations over a period of several months indicate that, for a given set of conditions, a definite relationship exists between the shrinkage, the loss in water from the specimens, and the cement content of the mixture.

A definite relationship between the original water–cement ratio of the mixture and the amount of water lost under the conditions of the test is also indicated. The relationships are given in Fig. 1, which shows that shrinkage increases with the increase in loss of water, which in turn increases with the water–cement ratio. Shrinkage also increases with the cement content. This diagram is not only useful in predicting probable shrinkage under a given set of conditions, but also in comparing the shrinkage in different concrete mixtures.

In order to estimate the probable shrinkage for curing conditions similar to those used in these tests, it is only necessary to know the water–cement ratio and the number of sacks of cement in 1 cu. yd. of concrete. When applying this diagram in the design of structures, it is important to reduce the values given in proportion to the degree of drying out and to the degree of restraint.

Briefly, the problem of designing a mix for minimum shrinkage by the use of this diagram resolves itself into the selection of the mix having the lowest quantity of cement per cubic yard for a given water–cement ratio. Any change in the size of the aggregate or in the grading, which permits the use of a larger quantity of aggregate per sack of cement, with a given water ratio, will be beneficial as long as the mix remains placeable.

With relationships established for a given set of conditions and materials, the investigation is being extended to include differences in curing, in type of aggregates, and in fineness and other characteristics of the cement.

SOUNDNESS TESTS OF AGGREGATE FOR CONCRETE

Surveys of concrete structures and highways throughout the country have disclosed some examples of disintegration resulting from failure of the aggregates and have shown the need for a comprehensive study of the variations in aggregate quality and its effect on the durability of concrete. Such a study, embracing petrographic and geologic studies in the field and in the laboratory, is now under way.

A major objective in this study is the development of some physical test by which the suitability of aggregates for use in concrete can be determined. It may be assumed that if the aggregate particles themselves can resist the destructive effects of freezing and thawing, and are sound under repeated wetting and drying, that they will be durable in concrete under all normal exposures. The tests ordinarily applied to aggregates are the sodium sulfate immersion and drying, and alternate freezing and thawing. Both of these are being used.

In addition, concrete and mortar specimens made from aggregates of different qualities are being subjected to freezing and thawing with a view to establishing, if possible, some correlation between their behavior when tested alone and when tested in concrete. Some of the significant results from this investigation appear in a paper by Dr. G. W. Ward and me, on "Durability Studies of Concrete and Aggregate," which was presented at the 1931 convention of the Association of State Highway Officials of the North Atlantic States.

DURABILITY OF CONCRETE

One of the most destructive natural forces tending to disrupt concrete is the freezing of the so-called "free water" entrapped in porous concrete. This is a condition which can be easily met when once recognized and which should be avoided. The disintegration of porous concrete under severe exposure will be promoted by the repeated setting up, in cement paste of low quality, of high stresses resulting from improper proportions and manipulation. Such failure may therefore be considered a fatigue failure. A high quality of paste will resist a large number of repetitions of stress before showing any indication of disintegration.

Several groups of freezing and thawing tests are under way for the purpose of determining the factors affecting durability, so that definite rules can be laid down for the production of concrete that will be lasting even in the severest climates. One of the outstanding results of these tests is the important effect of the water content on resistance to freezing and thawing, there being a material decrease in such resistance with increase in the water–cement ratio for mixes otherwise identical.

SURVEY OF STRUCTURES IN SERVICE

The behavior of a variety of concrete structures over a wide range of climatic exposures is being investigated. Over 650 structures have been examined in a nation-wide survey begun in 1928, attention being given almost exclusively to outdoor structures and particularly to those in direct contact with water.

Outstanding observations are as follows. The principal destructive agents are the repeated freezing and thawing of saturated, porous concrete and the solvent action of water finding its way through a porous concrete mass. The effect of climatic conditions was clearly evident. Concrete of a quality that showed rapid deterioration in northern climates was totally unaffected after years of service in regions free from severe frost action. Of particular significance was the observation that deterioration due to percolating water was almost wholly confined to joints, honeycombed spots, laitance seams, and other defective points resulting from improper manipulation. Almost without exception, defects in the concrete observed were not due to chemical disintegration resulting from the composition of the cement, but were the result of physical disintegration of areas of weak porous concrete, either through frost action or solution by percolating water.

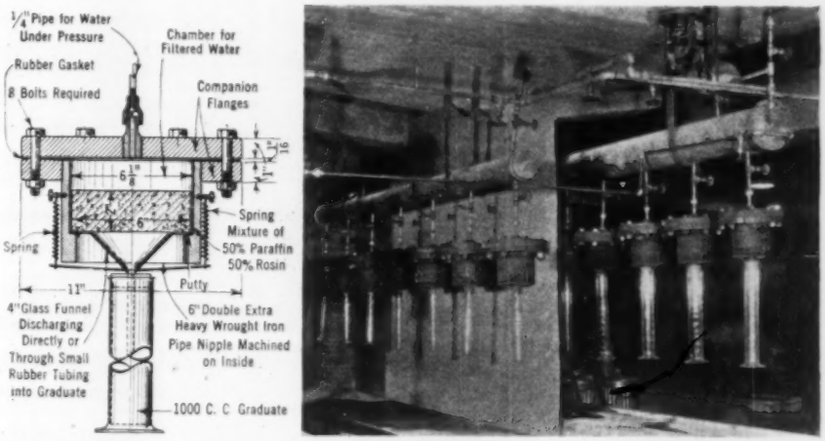


FIG. 2. APPARATUS FOR PERMEABILITY TESTS OF CONCRETE SPECIMENS

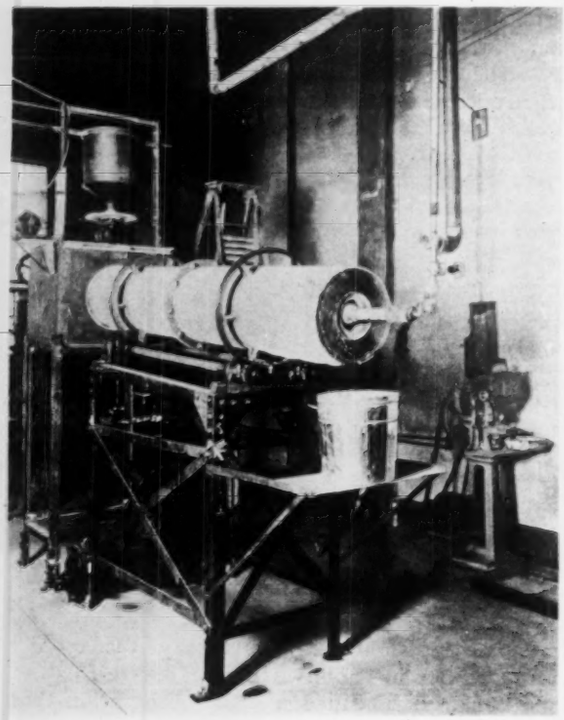
PERMEABILITY TESTS ON CONCRETE

There are very few published data which show the influence on permeability of the various factors known to affect the strength of concrete. Probably the best known tests are those of Prof. M. O. Withey, at the University of Wisconsin, and of W. H. Glanville, at the Building Research Station, England.

In Fig. 2 is shown the apparatus developed to investigate the factors affecting the watertightness of concrete. Specimens 6 in. in diameter, ranging in thickness from 1 to 12 in., are tested under water pressures up to 250 lb. per sq. in. The water which passes through the specimen is caught by a glass funnel, 4 in. in diameter, held against the center portion of the bottom surface of the specimen by means of springs.

Thus far the most significant results obtained are the marked influence on watertightness of the water–cement ratio and of the method and duration of curing. Very consistent relations having been found for all conditions of test, the water–cement ratio has been established as a fundamental factor in the permeability of any concrete mix. The method and extent of curing were found to have an even greater influence on watertightness than on

strength. Through additional curing, more of the mixing water is brought into chemical combination with the cement, thus building up an internal structure that is more resistant to the passage of water. Results of some



EXPERIMENTAL GAS-FIRED ROTARY KILN
Portland Cement Association Fellowship, Bureau of Standards

of the early tests in this investigation are given in the paper by F. R. McMillan, M. Am. Soc. C.E., and Inge Lyse, Assoc. M. Am. Soc. C.E., "Some Permeability Studies of Concrete," in the *Journal of the American Concrete Institute*, for December 1921.

A comprehensive and systematic investigation of the performance of walls of concrete masonry units, when subjected to standard fire tests, is now under way. It includes a study of fire resistance and wall stability as influenced by such factors as the design of the unit, its cement content, the character and gradation of the aggregate, curing, the type and quantity of the mortar, and the character of horizontal and vertical mortar joints.

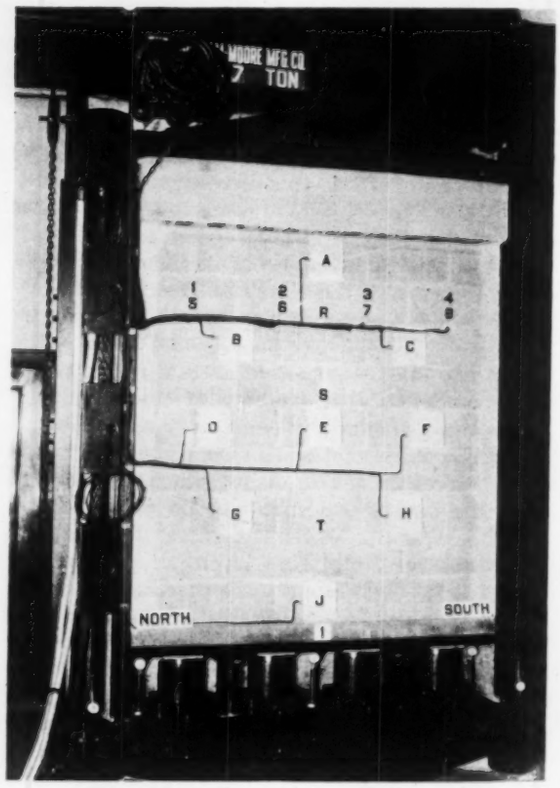
This work has involved the design and construction of a number of pieces of fire-testing equipment, so arranged that walls, $5\frac{1}{2}$ by 6 ft. in size, can be installed in a steel testing frame, loaded by means of hydraulic jacks, and exposed on one face to the flames of a vertical, gas-fired furnace. A view of some of the equipment is shown. The units for laying up the walls are made in the laboratory with equipment of standard make, so that it is possible to obtain the complete history of each variety or condition of unit from the time it is made until the assembled panel is ready to be tested. Fire-endurance tests are supplemented by other tests and by examinations designed to determine the composition of the materials and to obtain data on their physical properties—such as weight, absorption, the compressive strength of individual units—and on the relative load-carrying ability of the various wall assemblies before and after fire exposure.

Some of the factors under investigation have been found to have a very appreciable and definite influence on the fire-endurance period, while others have only a relatively small influence and can be varied within wide limits to satisfy local manufacturing conditions at the plant. The results of the ultimate-load tests conducted in connection with the fire-endurance tests have provided definite information regarding the stability and safety of concrete masonry walls after severe fire exposure.

While the results of this investigation apply directly to concrete masonry, information is being developed that will be of great value in the fireproofing of steel with concrete.

METHODS OF TESTING CEMENT STUDIED

Standard specifications and methods of tests for cement have been in force for over 25 years. During this time, the American Society for Testing Materials has been working almost continuously on the improvement of specifications and test methods in order to adapt them to new conditions. Much attention has been given to the development of methods of testing cement and concrete in order to standardize and improve the technic.



CONCRETE MASONRY PANEL IN PLACE IN GAS-FIRED FURNACE BEFORE TEST

In recent years, many tests have been carried out with a view to developing a better method of testing the strength qualities of cement than the present standard Ottawa sand briquet. These include tests on 2-in. cubes of neat cement water pastes and sand mortars of plastic consistency. Much of this work was done in cooperation with Committee C-1 on Cement, of the

American Society for Testing Materials, and with other interested laboratories.

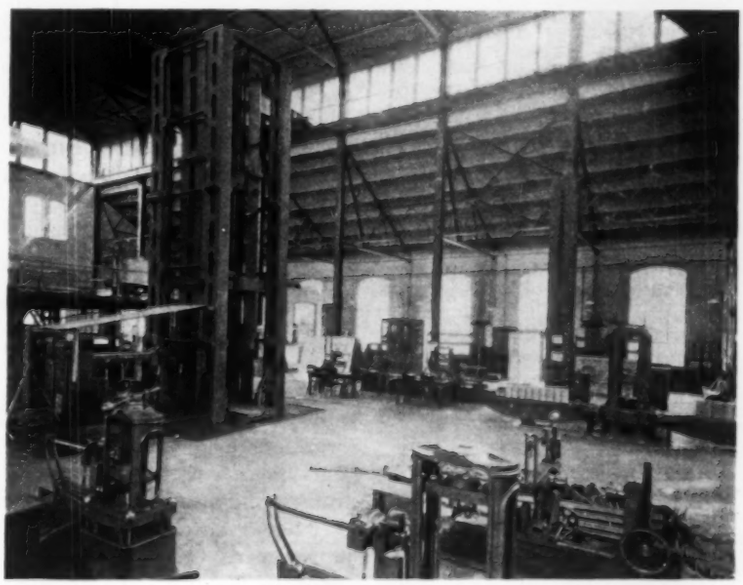
One of the investigations involved a total of about 62,000 tests, which were carried out in 47 laboratories on 32 different portland cements. Among other things, these studies revealed wide differences in the results of tests by the various laboratories on identical samples, and showed the need for calibrated laboratory equipment and control of temperature, humidity, curing, testing, and other conditions.

In this connection it may be of interest to point out that Committee C-1 on Cement, of the American Society for Testing Materials, in cooperation with the National Bureau of Standards, established in July 1929 the Cement Reference Laboratory for Standard Cement Testing, at the Bureau of Standards, Washington, D.C. The function of this laboratory is to give instruction in the established methods of making cement tests and the proper methods of maintaining testing equipment, and to calibrate such equipment submitted by manufacturers or purchasers. Its services are available to any cement testing laboratory on request from the directing head. Suitable certificates, covering apparatus only, will be issued to laboratories entitled to them. In addition to this general educational work in establishing a wider understanding and better use of testing methods, the laboratory plans to study various problems involved in the different operations of the standard cement tests.

COOPERATIVE INVESTIGATIONS

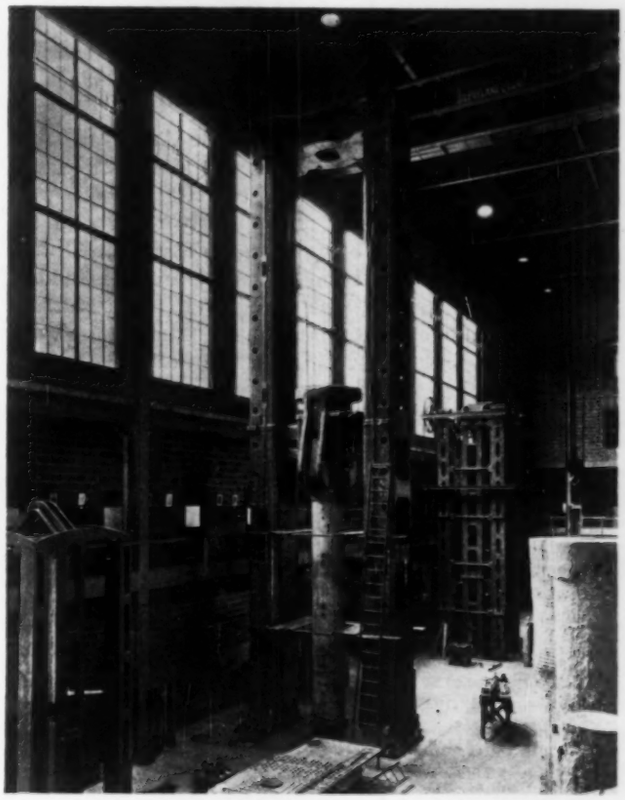
Research activities of the Portland Cement Association include several cooperative investigations. The cooperative research on portland cement at the Bureau of Standards was inaugurated in June 1924, through the establishment of the Portland Cement Association Fellowship, with a working staff of four research chemists and physicists. The program undertaken by the fellowship covers fundamental studies of the constitution and properties of the compounds existing in portland cement, and allied problems. Current investigations include such subjects as the influence of composition on the qualities of portland cement; the reaction of salt solutions on the constituents of set cement; volume changes in portland cement; and factors which determine the rate of set and their control.

As a first step in linking purely laboratory investigations with possible eventual plant practice, an experimental rotary kiln has been built which permits the production of relatively large quantities of cement clinker —about 10 lb. per hour—under controlled conditions.



INTERIOR OF THE FRITZ ENGINEERING LABORATORY, LEHIGH UNIVERSITY

Cooperative column tests are being carried out under the auspices of the American Concrete Institute at



STRUCTURAL RESEARCH LABORATORY, UNIVERSITY OF ILLINOIS

Lehigh University and at the University of Illinois, for the purpose of establishing the fundamental relationships between load, elastic properties, and ultimate strength of reinforced concrete columns, as influenced by variations in size, quality of concrete, amount and arrangement of reinforcement, rate, and method of loading, and the effect of continuous loading over long periods of time. This series of tests involves the making and testing of 572 columns and constitutes one of the most comprehensive column investigations ever undertaken.

Cooperative studies at the University of California include investigations on the effect of temperature, at the time of application of stress, on the compressive strength and actual stress deformation ratio of concrete;

the effect on compressive strength of moist curing at temperatures above 70 deg. fahr.; the effect of the heat of chemical reaction during the hardening process on the strength of mass concrete; and the influence of repeated high and low temperatures on compressive strength and on the thermal expansion of concrete.

OTHER CURRENT RESEARCHES IN THE UNITED STATES

Since its reorganization in 1924, the American Concrete Institute's Committee E-3 on Research—since 1929 known as Institute Committee 101 on Survey of Research in Progress—has made yearly reports to the institute on researches being carried out in the United States. The general function of this committee is to keep in touch with investigations on concrete and to furnish annually as complete information as possible on the work of various research agencies in the field of concrete and related materials.

Current researches reported by the committee are concerned principally with studies on:

- Constitution of portland cement
- Tests of high early strength cements
- Development of methods of testing cement
- Durability tests of aggregates
- Effect of size and shape of aggregate particles on strength
- Effect of heating aggregates prior to use
- Effect of grading
- Development of strength tests for fine aggregates
- Durability of concrete under various conditions of natural exposure
- Effect of admixtures
- Volume changes
- Fatigue
- Flow under sustained stress
- Determination of modulus of elasticity and Poisson's ratio
- Permeability
- Flexural strength
- Wear
- Workability
- Bond resistance of reinforced concrete beams under continued load
- Tests of arch bridges
- Studies of methods of reinforcing

Subjects on which research is needed, which have been reported to the committee and which are well suited to university or college facilities, include:

- Effect on bond resistance of mortar coating on reinforcing bars
- Effect of heating materials on the strength of concrete at early ages
- Influence of moisture content and temperature of specimens at time of test on tensile, compressive, and flexural strength
- Modulus of elasticity of high strength concrete
- Effect of long-continued mixing on strength and other properties
- Methods of testing the strength and resistance to weathering and abrasion of sands for use in concrete
- Tests for shale content of fine aggregate
- Significance of the various accelerated soundness tests for aggregates
- Effect of finely divided materials, such as clay, in aggregate
- Effect on transverse strength of coatings on coarse aggregate
- Relative effect of chemical admixtures in concrete, both as curing agents and as accelerators
- Fatigue of concrete under repeated static and impact loads
- Development of a positive, simple method of measuring workability of concrete, differentiating between unworkability due to lack of water and that due to improper proportioning of aggregates

Additional subjects are listed in the report of the Committee on Research of the Society for the Promotion of Engineering Education, presented in 1930 at Montreal.

Many laboratories are engaged in making tests of a routine nature on concrete and concrete materials. Routine testing is not considered pure research, nor are compilations of existing data, although the latter may be a necessary preliminary for an effective investigation of a given subject. Research is the seeking out of new and important information and, in its broad sense, may be defined as the careful and diligent search for facts and principles.

A typical research project consists of four fairly distinct parts: (1) the selection of a suitable subject; (2) planning; (3) execution; and (4) interpretation of the tests. Only a limited field in the subject to be investigated should be selected, and previous work in this particular field should be reviewed. Preliminary or exploratory tests of limited extent are frequently desirable in order to conserve time and effort.

Some researches fail of their objective for the following reasons: an attempt to cover too wide a field in a limited time; lack of control of temperature, humidity, and other conditions surrounding the tests; too few specimens made for a proper interpretation of results; the use of improper testing technic; a lack of adequate equipment. In concrete research it is particularly important that standard test methods, as developed by the American Society for Testing Materials, be followed. Lack of adherence to standard procedures has frequently been found to result in faulty data and erroneous conclusions.

Conclusions should be based on a large number of results rather than on a few. In general, not less than three, and preferably five specimens for each condition of test should be made; in important investigations, as many as ten specimens for each condition are sometimes made.

VALUE OF RESEARCH IN COLLEGES

There are a number of advantages to be gained by colleges which foster and participate in research work. Its value to the instructor lies in the fact that it keeps him in touch with new developments and stimulates him to participate in new fields of endeavor. As a result of his contact with research work, undergraduate instruction is improved.

The presence of this work in a college is stimulating to the student, for research is the foundation of engineering knowledge. By coming in contact with it, he develops methods of thinking that he can apply in solving his problems. It develops in him skill in analysis, initiative, accuracy, independence of thought, thoroughness, and patience. Yet little opportunity is offered in engineering courses, as at present constituted, for students to engage in or to receive training in this type of work. Only a few engineering colleges offer courses which permit even graduate students to do original research.

From now on research will be of growing importance in the lives of students. Therefore it is desirable to give more attention to this phase of training in order to supply the demands of industrial and scientific industries for research engineers. Opportunities are available in this type of work for well qualified engineering graduates, and specific information on the subject should be offered every engineering student, preferably early in the junior year. One or more special lectures on the nature, extent, value, and results of engineering research might well be given.

Highway Traffic Control

Long-Distance Travel Requires Safety at Higher Speeds

By MAXWELL HALSEY

TRAFFIC ENGINEER, NATIONAL BUREAU OF CASUALTY AND SURETY UNDERWRITERS
FORMERLY TRAFFIC ENGINEER FOR THE COMMONWEALTH OF MASSACHUSETTS

THE lengthening of the average motor-vehicle trip to extend between cities, counties, and states, has materially expanded the flow of rural traffic, and the increased speed of the automobile, when coupled with other factors, has multiplied accidents until those in rural areas are increasing faster than those in urban districts. These conditions have served at last to attract attention to the rural traffic problem. This paper has been prepared from an address delivered before the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University, July 18, 1930.

RURAL highway traffic is that traffic which is usually found outside of business and residential districts. In some instances it can be carried intact directly through such sections by means of grade-separated super-highways, but as a general rule, once it has entered a built-up area, it becomes mixed with urban traffic, loses its identity, and changes its operating characteristics.

While the fundamental factors of types of vehicles and road surfaces are often the same, there are many characteristics which make the control of rural highway traffic quite different from that of urban traffic. Some of these conditions vary geographically and others are influenced by the shading off and overlapping of business, residential, and strictly urban areas. Only those which have a direct bearing on traffic control will be mentioned.

In rural areas, the pedestrian problem is entirely different from that in cities. In the country, the relatively small number of pedestrians at intersections simplifies the operation of traffic-control signals, and the real difficulty is found between intersections, because the small percentage of pedestrians does not economically justify the construction of sidewalks. The improvement of highway shoulders is not a complete answer because pedestrians will still prefer the pavement. However, the only treatment practical at present is to provide shoulders sufficiently wide and smooth to permit comfortable walking.

The matter of highway lighting affects the pedestrian materially. Without such illumination the average person, dressed in dark clothes, is practically invisible to the motorist, for he is against a black background which affords no contrast. Here again the question of economy is involved, for highway lighting is apt to cost more than the actual maintenance of the roadway itself. At present the only solution appears to be to force pedestrians to walk facing traffic, but outside the lanes normally used by moving vehicles. Then, if vehicular traffic uses the lanes that are provided, no accidents will result.

Rural traffic is usually lighter in amount than that in urban areas. This fact has considerable effect on the type of device selected for its control. Some methods are only effective for heavy flows, and others only for light. Highway traffic will frequently vary in volume because of resorts or amusement places, in a manner entirely different from city traffic. Such a condition sometimes absolutely reverses the flow at an intersection. The changing of the main flow from one street to another then requires either an exceedingly flexible signal, capable of automatically changing its timing, or a manual change in the timing of the device.

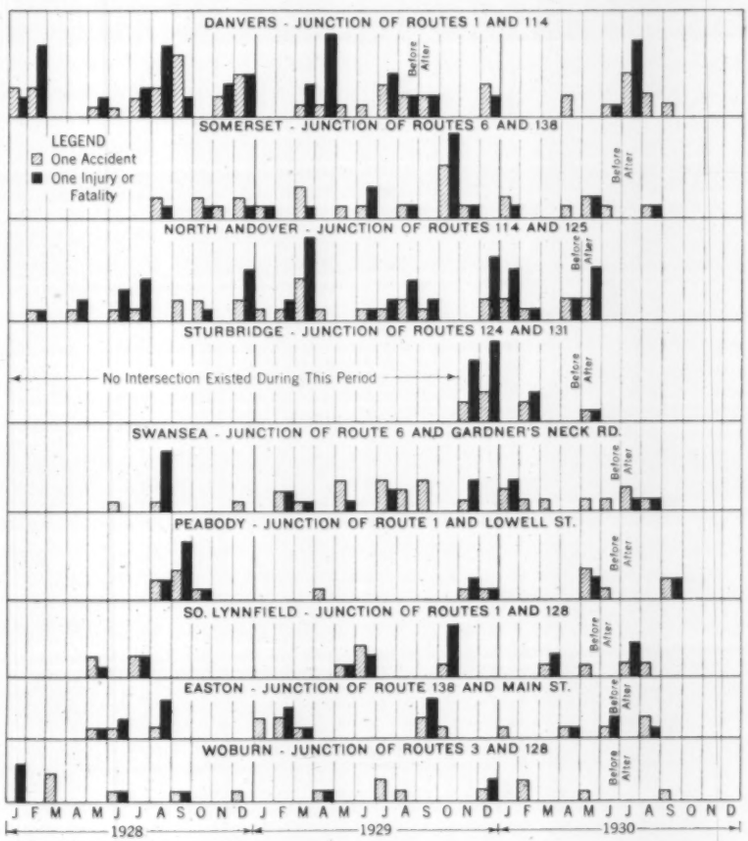

DANVERS - JUNCTION OF ROUTES 1 AND 114
SOMERSET - JUNCTION OF ROUTES 6 AND 138
LEGEND
One Accident
One Injury or Fatality
NORTH ANDOVER - JUNCTION OF ROUTES 114 AND 125
STURBRIDGE - JUNCTION OF ROUTES 124 AND 131
No Intersection Existed During This Period
SWANSEA - JUNCTION OF ROUTE 6 AND GARDNER'S NECK RD.
PEABODY - JUNCTION OF ROUTE 1 AND LOWELL ST.
SO. LYNNFIELD - JUNCTION OF ROUTES 1 AND 128
EASTON - JUNCTION OF ROUTE 138 AND MAIN ST.
WOBURN - JUNCTION OF ROUTES 3 AND 128
Before
After
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1928
1929
1930

FIG. 1. ACCIDENTS BEFORE AND AFTER INSTALLATION OF TRAFFIC SIGNALS
Comparison at Nine Intersections

In rural areas the percentage of commercial traffic is much smaller than in cities. The 1927 survey in Boston showed that about 20 per cent of the total traffic counted in the central business district was commercial. The 1930 state-wide survey of Massachusetts revealed that only about 10 per cent of the total traffic counted at 28 key stations was commercial. This difference of 10 per cent has a

considerable effect on the methods of control which should be used.

MOTORISTS' ATTITUDES DIFFER

There is a decided difference in the mental attitudes of motorists driving in rural and urban areas. Those in rural sections are apt to be making a longer trip and will not be bothered to make all the safety stops which their city cousins may be perfectly willing to do. If they did they would never get to their destinations. The longer the trip the more difficult it is to obtain frequent changes in operating speeds. Long stretches where 40 miles an hour is safe are apt to dull the motorist's sense of danger. If he slows down to 30 miles an hour when he arrives at an intersection with a safe approach speed of 20 miles an hour, he feels that he is going very slowly and is perfectly safe. This matter of mental attitude must be carefully considered in all the methods and devices used for highway traffic control.

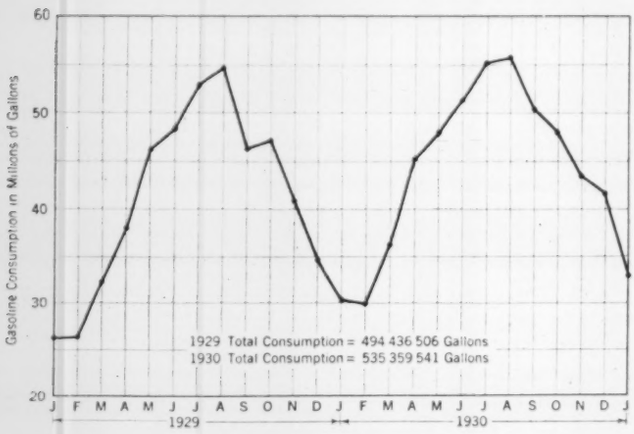

Gasoline Consumption in Millions of Gallons
60
50
40
30
20
1929 Total Consumption = 494 436 506 Gallons
1930 Total Consumption = 535 359 541 Gallons
J F M A M J J A S O N D J F M A M J J A S O N D J
1929
1930

FIG. 2. GASOLINE CONSUMPTION IN MASSACHUSETTS BY MONTHS

The greatest difference between rural and urban traffic is speed. The average speed on highways is far in excess of the average in cities. This difference has an important effect on control. It presents several definite problems. The first of these is the question of adequate visibility. All devices and control methods must be understandable to the motorist at a considerable distance if he is to be able to stop, turn, or make whatever movement the control device asks of him. The second problem is the necessity for increased braking distances whenever stops or slower speeds are required; and the third is the provision of additional passing facilities, for on the open highway there is a greater difference between the speeds of commercial and passenger vehicles than exists in cities where lower speeds generally prevail.

HIGHWAY SPEEDS A PROBLEM

One of the greatest difficulties inherent in the rural highway traffic problem is that many administrators have not been willing to face the facts and prepare their roadways for higher average speeds. They have assumed that everyone drives too fast and that it will be simply a matter of time before highway speeds are brought under control by rigid law enforcement. The difficulty lies, however, in the fact that those responsible for the enforcement of speed laws are too amenable to political influence and to the wishes of the motorists themselves. This fact has prevented the reduction of highway speeds to a point where existing roadways would be capable of carrying vehicles safely.

Increasing highway speeds merely reflect the individual's demand for increasing mobility. The twentieth century has placed such a high value on time that the motorist does not like to waste any more of it than necessary in getting from one place to another. It was only a few years ago that highway speed was limited by the class of car the individual could afford. It is true that the inexpensive cars could go fast, but they were not comfortable at high speeds and wore out much more

FIG. 3. ACCIDENTS AND INJURIES BEFORE AND AFTER INSTALLATION OF TRAFFIC SIGNALS AT A TYPICAL INTERSECTION

REDUCTION IN ACCIDENTS AND INJURIES

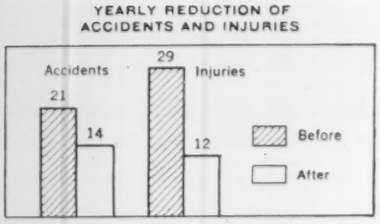
Rate, 20 months before and 13 months after	Before	After	Reduction
Average number of accidents per month	1.65	1.17	−0.48
Average number of injuries per month	2.30	1.00	−1.30
Number of injuries per accident	1.14	0.86	−0.28

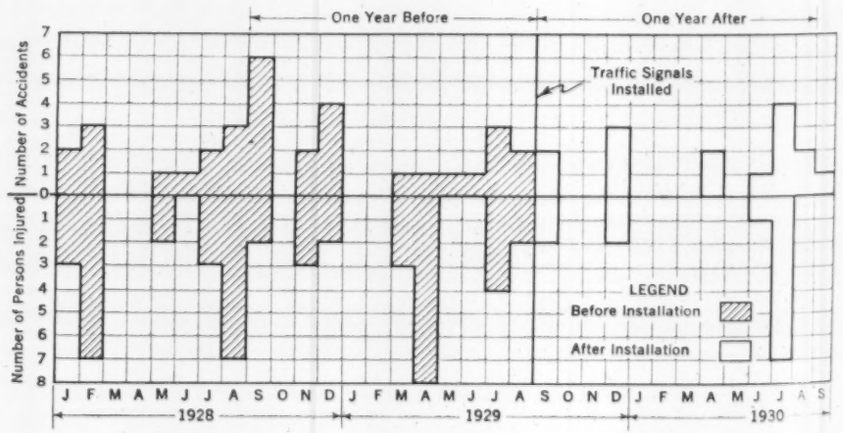
CLASSIFICATION

Cause	Accidents 1 Year			Injuries 1 Year		
	Before	After	Change	Before	After	Change
Cross movement	11	1	−10	19	0	−19
Head-on	1	0	− 1	1	0	− 1
Unknown	9	11	+ 2	4	9	+ 5
Rear-end	0	2	+ 2	0	3	+ 3
Total	21	14	− 7	24	12	−12

FLOW OF VEHICULAR TRAFFIC

Variable	1929	1930
Average daily flow for 16 hours	11,772	14,123
Vehicles per hour	735	884
Per cent of increase	....	20.0




One Year Before
One Year After
Traffic Signals Installed
Number of Accidents
Number of Persons Injured
LEGEND
Before Installation
After Installation
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
1928
1929
1930

rapidly. Car manufacturers soon realized this, and the cheapest cars now on the market have comfortable driving speeds which more nearly approach those of higher priced cars, and they are capable of traveling at speeds in excess of those which existing highways can take care of in safety.

There can be no question but that the higher comfortable speeds of inexpensive cars, which constitute some 70 per cent of present registrations, have increased the average highway speed at least 10 miles an hour. Both the vehicle and the surface of the highway are now capable of permitting the average speed desired by most motorists, but the design of intersections and straightaways is not such as to make these speeds safe.

The point is, then, that people want increased mobility, as evidenced by the rapid development of automobiles and airplanes, and the traffic authorities should prepare their highways for increased speeds with safety—proposed laws and rigid enforcement notwithstanding. Average highway speeds have not yet reached their maximum, and unless highway design is improved to keep pace with them, more and more accidents will result.

CAPACITY OF HIGHWAYS

It is now generally recognized that the intersection limits the capacity of a highway system to a far greater extent than does the width of the highway between intersections. If the existing delays at intersections could be reduced, a higher over-all speed would be possible and the motorist might be satisfied with a more moderate speed between intersections. Consequently, the most important rural highway problem today is the provision of safer and more efficient intersection control. Such methods as vehicle-actuated signals, rotors, and grade separations have already been developed, and it remains only to apply them properly.

An interesting example of what can be done in this line occurred in Massachusetts, where an intersection of two highways, the average speed on one of which was from 35 to 40 miles an hour, had been causing a large number of serious accidents. Motorists had failed to respond to warning and stop signs, and rotary traffic or grade separation was not economically justified. Vehicle-actuated signals, which were finally installed, reduced the number of accidents 33 per cent and their severity 50 per cent, yet permitted an average intersection speed on the more important highway of 35 miles an hour, and an increase in traffic flow of 20 per cent.

Another rural control problem is that of carrying through traffic around or through small towns with safety. The state accident spot-map of Massachusetts indicates clearly that wherever high-speed traffic is brought through built-up areas, where there are small stores, many pedestrians, and slow urban traffic, a large number of accidents occur. The two elements will not mix with safety.

Ordinarily, there are two ways in which this problem can be solved. The one that is preferable is to provide a circumferential or by-pass route. This method, particularly if it is augmented by adequate grade separations, provides a complete solution. Frequently, however, conditions are such that additional roadways cannot be economically procured, and it becomes necessary to route the traffic through the main street. In rare instances, recourse may be had to elevated structures, but their cost is so high that it is difficult to justify them economically. The only alternative is to design the through route so that it will carry traffic at slightly reduced speeds with safety. This can be done by the use of medial strips, or separating islands.

The roadway for the use of through traffic should consist of not less than two 10-ft. lanes for each direction,

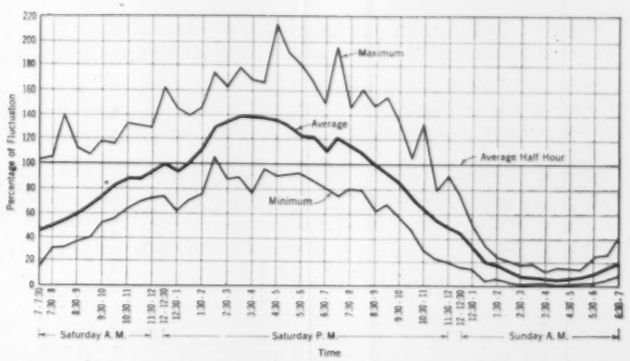


FIG. 4. HOURLY FLOW OF TRAFFIC OVER A 24-HOUR PERIOD
Survey by the Department of Public Works of Massachusetts, 1929

separated by a raised medial strip. For local traffic, at least two 10-ft. lanes should be provided for each direction, and these should be separated from the through-traffic surfaces by raised islands, varying from 2 to 10 ft. in width. Then, with grade separations, or with a progressive or actuated signal system, the through and local traffic could flow or park in safety. The minimum width of this design, not including sidewalks, would be only 86 ft., which is certainly not excessive in consideration of the safety it would afford. At a lane flow of 1,500 vehicles an hour with grade separations, this design would carry approximately 6,000 vehicles of through traffic an hour, or the equivalent of any good 40-ft., 4-lane highway. In addition, 40 ft. of roadway would be available for local travel and parking.

FACTS TO BE CONSIDERED

In conclusion, the basic facts which the rural highway traffic engineer should know if he is to successfully control traffic will be stated. Accident records should be kept in such a manner that collision diagrams may be drawn for each accident. The location of accidents is the most important factor, for, unless the number occurring at particular points is known, remedial efforts cannot be concentrated where they are most needed. These facts should be portrayed on spot-maps and collision diagrams. A graphic presentation of data collected by the Department of Public Works of Massachusetts is given in Figs. 1 and 3.

The amount of traffic using each highway, and the variation of its flow by years, months, days, and hours, represents the most fundamental information available. It should be gathered at intersections, where all turning movements and classes of vehicles can be recorded. The facts should be linked together so that a continuous flow on the main highway system is secured, and then presented on a flow map, such as that for the State of Massachusetts, made by the State Department of Public Works, a section of which is shown in Fig. 5.

For each mile of a main highway the average speed of vehicles should be known. These data should include the separate speeds of vehicles passing through the intersections, and the material should be presented on a speed map showing by symbols the different classes of average speeds. Unless the material is presented in such a way that it can be understood at a glance, it will not be used to any great extent. Facts on speed and volume have a direct bearing on the accident situation; if accidents are spotted by tacks on a composite flow and speed map, the relationship of the three factors can readily be determined.

Wherever speeds are excessively low, delay studies should be made. This is particularly true at intersections where traffic is required to wait for any length of time. Delay should be counted by car-hours and reduced to seconds per car. Its cost may then be estimated in dollars and, when added to the cost of accidents, may be used to economically justify traffic signals, or new construction, such as traffic rotors or grade separations. When by-passes or circumferential highways are to be built, origin and destination studies should be undertaken to determine what use would be made of the proposed construction. There are many other studies which are of value, such as those on traffic lanes, turning, and safe approach speeds.

Some interesting compliations of data are given in Figs. 2 and 4. In Fig. 2 is shown the gasoline consumption in Massachuetts by months, during 1929 and 1930. The graph, Fig. 4, gives a vivid presentation of traffic flow by hours during one week in August 1929, as counted at 28 key stations distributed over the state.

BUILDING SAFETY AND FACILITY INTO HIGHWAYS

It is a fundamental principle that safety and facility should be incorporated in the highway during its construction. Roadways should be so built as to make it difficult, if not impossible, for motorists to do the wrong thing. A few examples will indicate what can be done.

Raised center strips will prevent head-on collisions by forcing motorists to drive on the right-hand side of the highway, by eliminating mid-block turns, and by reducing headlight glare. The building of three- and four-lane highways, with the outside lanes of smooth cement and the inside lane or lanes of rough macadam, encourages motorists to use the attractive outside lanes, leaving the center free for passing. Improved shoulders will induce motorists to park off the traveled way.

Since motorists driving at a high speed will not pass close to fixed objects, ample space should be provided between the guard-rail and the outside lane to dissuade drivers

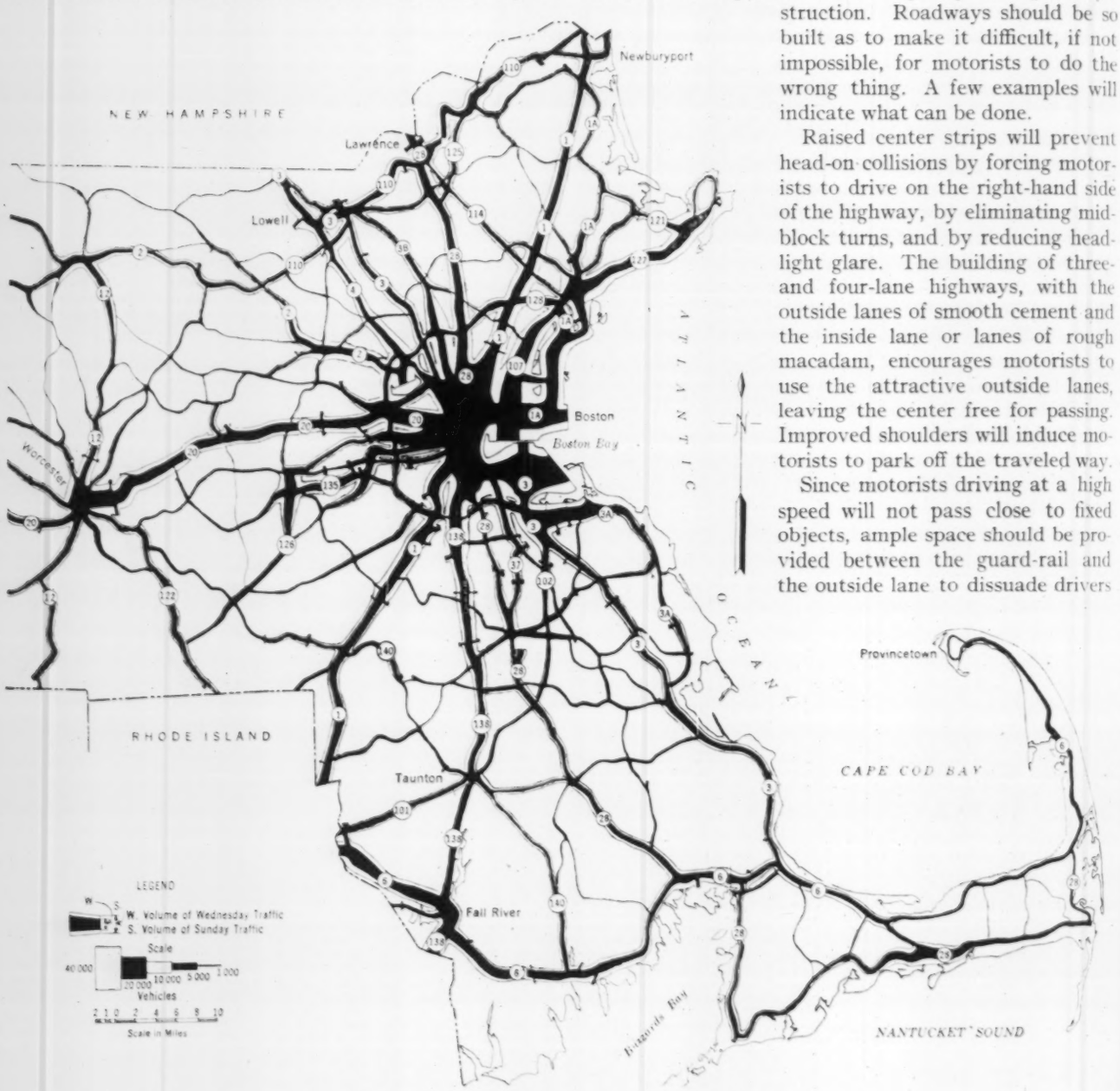


FIG. 5. SUNDAY AND WEDNESDAY FLOW OF VEHICULAR TRAFFIC
Massachusetts, August 1930

from swinging toward the center and endangering cars in the passing lane. The erection of channelizing islands in the throats of wide intersections prevents motorists from cutting the corner when making left turns. These examples show how automatic enforcement can be obtained by construction.

RELATIVE USE OF TRAFFIC DEVICES

Each traffic device has its own particular use—no one will cure all traffic ailments any more than one medicine will cure all diseases. The facts discussed previously can be used as a guide in making a proper selection.

To begin with the ultimate in intersection control—grade separations should only be installed when the total economic cost of accidents and delays is equal to the yearly cost of building and maintaining such a structure, probably estimated on the basis of a 20-year life. Since the cost will run from $100,000 to $200,000, it is obvious that it will take many accidents and delays to justify such an expenditure.

As to the rotary traffic method of control, it probably gives a capacity second only to grade separation. Its cost is much less but it should be justified by the method previously used.

Actuated signals probably give the third highest capacity to an intersection. Their cost is even less, and can be justified quite easily. Under light traffic flows, where conditions change rapidly, they cause much less unnecessary delay than the ordinary fixed-cycle signal, and consequently they can be justifiably installed for accident reduction as well as for the relief of congestion.

Fixed-cycle signals are only beneficial in reducing delay if the traffic volume is 1,000 vehicles an hour or more, and if at least one-fourth of the traffic is on the side street. For the reduction of accidents under lighter traffic flows, they are only effective if the proportion of traffic is such as to permit the short cycle necessary for efficient operation under light traffic conditions. Obviously, if the flow is so light as to demand a 40-sec. cycle, and the proportion of flow is 90:10, a division of 36 sec. and 4 sec. cannot be used, and resort must be had to an actuated signal.

Flashing beacons are nothing but animated signs with greater attracting power. They should be used wherever a warning or channelization is needed. Their purpose is to slow down speed and force proper turning.

Stop signs are effective under two sets of conditions—first, where the flow of traffic on one street is much greater than on the other, so that the traffic stopped is light and the resulting delay reasonably small; and second, where the average speed at an intersection is considerably in excess of the "safe approach speed" for the intersection in question. Here again, however, the volume and the speed of traffic, as shown by the counts, are the selecting factors. Stop signs, if they can be enforced, are preferable to fixed-cycle signals. That device should be used which will cause the least unnecessary delay and yet solve the problem.

TREATMENT REQUIRED AT DANGEROUS INTERSECTIONS

Traffic signs are the first treatment a dangerous point should receive. However, they should be used only where they are absolutely necessary. Safe-approach speed studies immediately following highway construction, and accident records later, should determine their use.

No device should ever be installed without before and after studies—studies beforehand to indicate which device, if any, is needed, and studies afterward to show the results obtained.

BERKELEY COURT, BAKER STREET, LONDON

As an example of modern British structural engineering, the construction of an ultra-modern nine-story apartment house on Baker Street and Oxford Circus, London, is of peculiar interest. Here the use of hollow brick to back up the face brick in the walls above the fourth floor effected a saving in weight of almost 1,300 tons on the foundations, with a resulting economy in steel cost. The foundations of the building are on London blue clay. Following Terzaghi's theories, footing pressures were reduced from 4 tons, on smaller bases, down to 3.3 tons per sq. ft. on the largest. Berkeley Court occupies an island site over one acre in extent. It is surmounted by a roof garden of generous dimensions. The photograph is furnished by courtesy of Donovan H. Lee, Assoc. M. Am. Soc. C.E., the engineer in charge of the structure.

HINTS THAT HELP

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Estuary Tidal Prisms Related to Entrance Areas

By MORROUGH P. O'BRIEN

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING
UNIVERSITY OF CALIFORNIA, BERKELEY

SEVERAL writers have intimated that there is some relation between the general dimensions of the entrance to a tidal estuary or bay along a sandy coast and the volume of the tidal prism, but there appears to have been no previous attempt at a definite correlation. In Fig. 1, the area of the entrance section below mid-tide

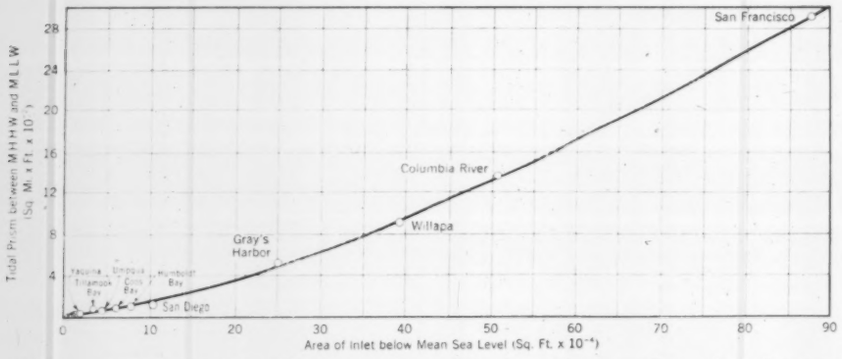

FIG. 1. PLOTTED RELATION BETWEEN TIDAL PRISM AND AREA OF ENTRANCE SYSTEM

is shown as a function of the tidal prism between mean lower low water and mean higher high water, and the small deviations from the curve indicate a unique relationship between the two quantities. A logarithmic plotting of the same data shows that the curve can be represented with sufficient accuracy by

$$A = 1{,}000\ T^{0.85}$$

where

T = volume of the tidal prism in square mile-feet between MLLW and MHHW, and has a value ranging between 7.0 and 3,000

A = area of the entrance section below mid-tide in square feet

Along the Pacific coast of the United States, the tide exhibits a diurnal inequality, with the "long run-out" following higher high water. Since this peculiarity in the daily sequence gives ebb currents strong in comparison with the flood currents, the diurnal range has been used in computing the values used on the graph. Tides along the Atlantic coast do not have this inequality and the mean range was used for the tidal prism of Absecon Inlet.

The tidal prisms used in the figures and in Table I were taken from reliable sources and were checked by planimeter measurement of the areas shown on the charts of the U.S. Coast and Geodetic Survey. It is always difficult to estimate the tidal prism and there are undoubtedly some errors in the values used, but it is believed that these errors are too small to affect the curve's validity.

Where twin jetties have been constructed, the area of the entrance section was taken between the ends of the jetties; for entrances which are unimproved or improved by only one jetty, it was measured at the narrowest point. Data were taken from the most recent surveys of the U.S. Engineers or the U.S. Coast and Geodetic Survey.

Except in the case of Tillamook Bay, the yearly variations in inlet area are small for all of the harbors included. The area of the entrance to Tillamook Bay has increased 300 per cent since 1898 and appears to be approaching the curve. At San Diego, the area is greater than is indicated by the curve, but this is accounted for by dredging and by the relatively light littoral sand movement.

The explanation of the relation shown appears to be that the pressure of the littoral sand motion tends to reduce the entrance area until the tidal currents are sufficiently strong to remove material from the ends of the encircling sand spits. If the original entrance area is too small, as may have been true of San Francisco Bay, the tidal currents will remove material until the proper area is obtained

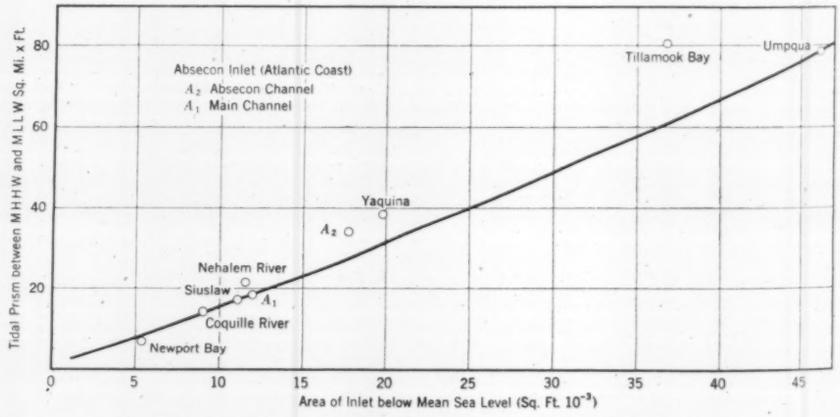

FIG. 2. DETAIL OF RELATIONSHIPS SHOWN IN FIG. 1. Enlarged Scale of Lower Points

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NEWPORT BAY AND BALBOA ISLAND, JULY 4, 1930

Along the Pacific Coast, Tidal Entrances Usually Lie Between a Rocky Headland and a Long Narrow Sand Spit

It was thought at first that deviations from the curve might be explained on the basis of the coarseness of the sand forming the bar and the adjacent beaches, but the data available do not indicate a tendency toward an increase or decrease in the area with increasing coarseness of the material. In this connection it should be noted that, although fine material is more easily transported toward the entrance by waves, winds, and currents, it is also more easily moved away by the tidal currents, and these two factors appear to neutralize each other. Computations of the cross sectional area of the entrance, based on tidal currents and their scouring velocity, indicate that a given tidal prism will maintain a larger entrance in fine sand than in coarse. The trouble with this method is that it neglects the lateral sand pressure, which is bound to be greater in fine sand.

The relation here established has an important bearing on the desirability of reducing the tidal prism by artificial means. One of the proposed sites for the "Salt-water Barrier" in San Francisco Bay would result in a 40 per cent reduction in the tidal prism and there seems to be little doubt but that this would cause a general shoaling of the entrance.

This relationship is important in small bays where a relatively large percentage of the tide lands is being reclaimed by dredging from the channels. Reduction in the tidal prism due to depositing the dredged materials between low- and high-water levels is not compensated for by increased channel depth, and a deterioration of the entrance is to be expected.

TABLE I. RELATION BETWEEN TIDAL PRISM AND AREA OF ENTRANCE SECTION

HARBOR	TIDAL AREA	DIURNAL RANGE	TIDAL PRISM	AREA BELOW MSL	DATE	JETTIES
	In. Sq. Mi.	In. Ft.	Sq. Mi. × Ft. Between MLLW and MHHW	In. Sq. Ft.		
Gray's	65.0	9.1	518.0	251,200	1928	Twin jetties
Willapa	131.2	9.1	913.5	393,800	1929	No jetty
Columbia River	171.8	6.3	1,370.0	508,000	May 1930	Twin jetties
Nehalem River	2.7	8.0	21.6	11,550	July 1925	Twin jetties
Tillamook	10.9	7.4	80.7	36,930	1929	Single jetty
Yaquina	5.0	7.7	38.5	19,785	1920	Twin jetties
Siuslaw	2.5	6.9	17.3	11,100	1916	Twin jetties
Umpqua	11.6	6.8	78.9	46,200	Nov. 1929	Single jetty
Coos Bay	16.1*	6.7	90.2	61,120	1929	Twin jetties
Coquille	2.4	6.8	13.9	9,020	1929	Twin jetties
Humboldt Bay	18.5	6.2	120.0	78,600	July 1929	Twin jetties
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Newport Bay	....	5.1	7.1	5,895	1929	Twin jetties
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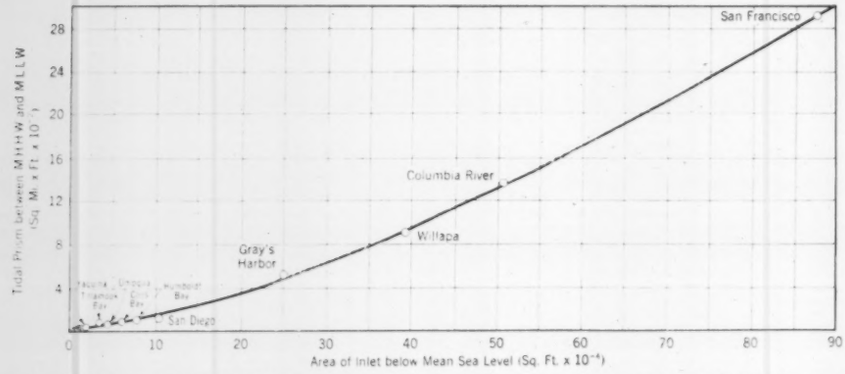

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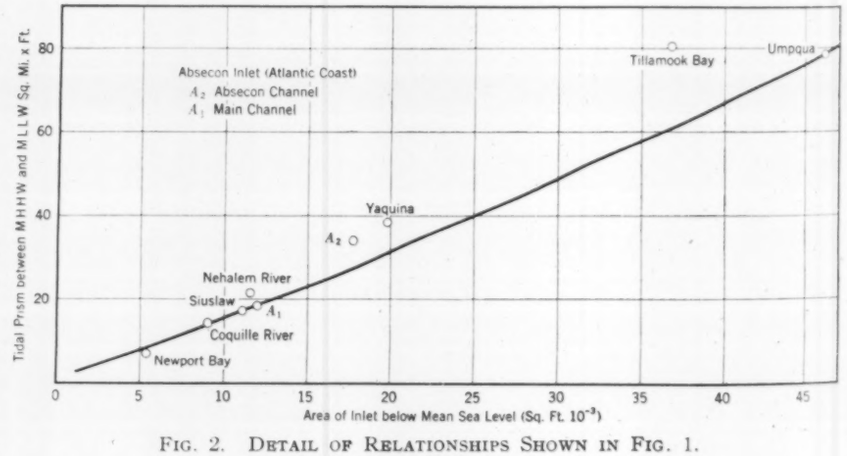

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OUR READERS SAY—

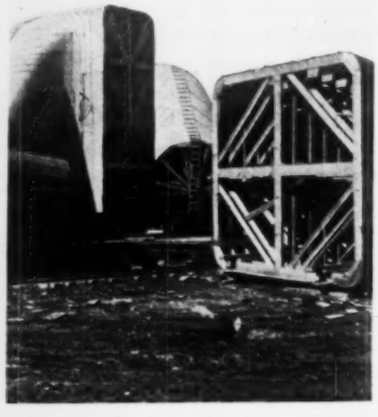
In Comment on Papers, Society Affairs, and Related Professional Interests

Construction Difficulties on the Spier Falls Project

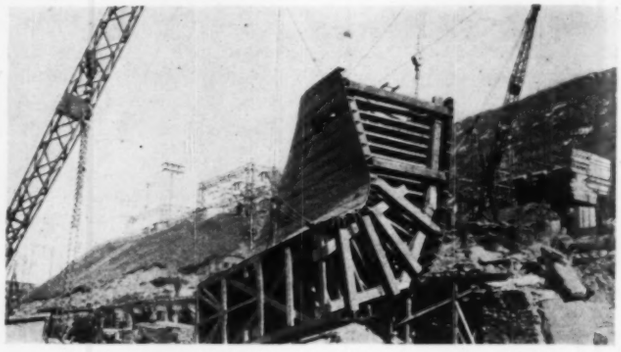
DEAR SIR: The article by Colonel Hogan on the Spier Falls development, in the March CIVIL ENGINEERING, covered the subject so thoroughly that little can be added. However, one or two features of construction methods might be commented upon.

The most difficult and interesting part of the work from a construction standpoint was the excavation of some 77,000 cu. yd. of solid rock and masonry, mostly behind leaky cofferdams, in the dead of a northern New York winter. In addition to this, the work was located so that it was entirely surrounded by sensitive structures—a power house, substation, high tension transmission line, and operators' houses. The only safe method of blasting in such restricted quarters was to use a great number of drill holes with light charges on 40 per cent blasting gelatin, and to cover all shots amply with blasting mats. Hemp, wire cable, and log mats were used, but the last proved the most satisfactory. They were made from green logs cut in the neighboring woods, each 6 to 10 in. in diameter, and 20 ft. long, with a hole bored in either end. Thirty or forty logs, according to size, were strung on cables with a loop at the top for handling with a derrick. When a log was splintered, the remnant could easily be removed and the remaining logs would slide along the cables and close the gap. Against vertical faces to be blasted, this mat was suspended from the derrick.

Next in point of interest was the building of transition sections and draft tube forms on a flat piece of ground some distance from the work and the transportation and lowering of these into place on their foundations. The "elbow" section of draft tube form was built in two pieces, each weighing about 20 tons. These sections, which were built on their sides, had to be braced sufficiently to be skidded down a narrow road to the site of the work, picked up, turned to an upright position in the air, and lowered into place without undue distortion. As it required nearly a month to build these forms where working conditions were favorable, it is assumed that an equal amount of time would have been required had they been constructed in place after the pouring of foundation slabs. It is doubtful if the construction schedule could have been maintained without this saving of time. Another advantage of constructing special forms in advance is that greater attention can be devoted to building them to true lines and making a more workmanlike job throughout.



FORMS CONSTRUCTED IN YARD



A TRANSITION SECTION BEING MOVED INTO PLACE

J. C. BALCOMB, M. Am. Soc. C.E.
Engineer in Charge of Construction
Spier Falls Power Project

Glens Falls, N.Y.
March 18, 1931

River Cut-offs Fail to Solve Flood Problems

SIR: My interest in the Brazos River project, so ably described by Major Fox in the January issue, goes back to an early stage of construction when I was serving as Division Engineer. In the broadest sense, this work divides itself into two parts—navigation, and flood control. So far as navigation is concerned, the blocking of the river and the diverting of the waters into the Gulf has probably gone far toward solving the problem, but I am not so certain that the plan provides a solution for the control of the flood flow of the river.

There is nothing new in proposing to make a river enlarge its own channel, but never to my knowledge has it been a success. The theory goes far back—it has been offered repeatedly in connection with flood plans for the Mississippi and Sacramento Rivers—and assumes that if you increase the flow of water in a river channel by levees, you will increase the capacity of the channel, and to almost any limit. This theory has not proved to be correct. In all cases of which I have knowledge it has failed to give the results claimed. You cannot divert the flood waters of a river through a channel and expect that channel to gain materially in capacity. In my opinion, it will gain little over its original capacity. If that is greatly deficient for the flood flow, there is not one chance out of ten that it is ever going to gain any material increase.

Regarding this Brazos diversion, I believe that if the new channel is deficient in flood carrying capacity as it now stands, the only possible hope of its gaining any material increase is through the occurrence of a series

of small and gradually increasing floods extending over a long period. That, however, is not the way floods occur. It is easy to read discussions along this line and reach the conclusion that the problem is solved. Those who have had little experience with flood channels and are unfamiliar with the theories involved, must go slow in accepting what is offered as to the ability of a river to create for itself additional channel capacity.

In recent years, I have given much thought to the straightening of rivers. In my opinion, engineers dealing with flood control grow more and more suspicious of cut-offs as they study the problems, and those who deal with navigation very promptly give up the consideration of their use. It is a fine thing to talk about cutting off a bend and to demand that the river be straightened, but in doing so the way river channels are formed and maintained is ignored. There is no more reason to expect a river to remain straight where a cut-off has been made two years before and no signs of starting a bend have appeared, than for one to go outside on a sunny day and say, "The sun is shining; it will never rain." Cut-offs on the rivers of this country, as flood protection works, give no promise. They have been tried on the Sacramento and abandoned as a failure.

We are now carrying out on the Mississippi River an experiment with a cut-off of magnitude. We deliberately permitted the river to initiate a cut-off in 1929–1930. Adequate data covering flood stages and river channel conditions previous to the beginning of this cut-off are available, and each year all such additional data are being collected as will be needed in connection with the complete study which will be made when the cut-off has been accomplished and river conditions in the vicinity have again become normal.

It is believed that this will be the first complete and thorough study ever made in this country to show how a cut-off occurs in nature, what happens during its formation, and what is the final effect on the regimen of the river. Incidentally, a laboratory study will be made of this same cut-off with the idea of determining how nearly the results obtained in the laboratory agree with those of the corresponding experiment made by nature.

THOMAS H. JACKSON, M. Am. Soc. C.E.
Brigadier-General Corps of Engineers, U.S.A.

Vicksburg, Miss.
April 8, 1931

Hydraulic Studies of Brazos Diversion

TO THE EDITOR: The Brazos River project, described by Major Fox in the January issue of CIVIL ENGINEERING, is of especial interest in this day when our attention is so much attracted to studies of river hydraulics, for the reason that there has been created by this diversion of the Brazos an opportunity for us to study and reach final conclusions on a great many points that are moot subjects among those who are interested in river hydraulics. The Brazos river is unique among alluvial streams, so far as I know, in that it is the only one of any importance that has but one mouth.

The diversion channel is shorter than the original channel by about $1^1/_2$ miles, which is a considerable percentage of the length of the original river section which it replaces. This must naturally create a disturbance of the regimen of the stream. This diversion channel was not excavated to the full dimensions of the original channel. The over-bank area between levees added to the excavated section would be larger than the cross section of the main stream, but the excavation channel for a considerable part of its length is merely a sort of guide channel, reliance being placed on freshets, which have occurred and will occur, to enlarge it as required.

There are possibilities of many interesting hydraulic studies on this diversion channel. The citizens of Freeport, where there is located a very large industrial corporation, have volunteered to cooperate with the Corps of Engineers in providing technical assistance to carry forward, or to aid the corps in carrying forward, any hydraulic studies which it may be sufficiently interested to indicate. Such studies are now being made.

In think that in the course of a relatively brief period of time we will be able to gather much information of great value to the profession as a result of these studies.

J. F. COLEMAN, Past-President Am. Soc. C.E.
J. F. Coleman Engineering Company, Consulting Engineers

New Orleans, La.
April 1, 1931

Shortening May Benefit a River

TO THE EDITOR: In connection with the Brazos River improvement, described by Major Fox in the January issue, I should like to call attention to the fact that in some parts of the world rivers have been successfully shortened. Thus, for example, a 64-mile stretch of the River Rhine, which is about 800 ft. wide, has been shortened near Gemersheim from its original length to 28 miles. The work of accomplishing this extended through decades. The river itself did the work of cutting off bends. Whenever, by this process, a bank was pushed back to its predetermined location, it was revetted and protected against further cutting away.

Rivers such as the Mississippi, among them the Sacramento of California, have many stretches that could be shortened with benefit to the river, both above and below the cut-off. A large river endeavors to maintain the regimen which it has established in centuries of flow, a fact which makes it possible to predict with some confidence what the ultimate effect of any material change in its length will be. This statement applies, of course, only to rivers flowing in alluvial valleys. In various parts of the world, advantage has repeatedly been taken of this law of river dynamics. It is to be hoped and should be expected that, as applied at the mouth of the Brazos, it will also prove to be successful.

C. E. GRUNSKY, Past-President Am. Soc. C.E.
The C. E. Grunsky Company, Engineers

San Francisco, Calif.
April 4, 1931

The Present Status of Flood Control

SIR: The paper by Mr. Coleman, entitled "Mississippi River—A National Flood Problem," published in the February issue, is an interesting contribution on this much-discussed subject. The portion of the river that has been treated in Mr. Coleman's paper is known as the Lower Mississippi, as it extends from Cairo, Ill., to the Gulf of Mexico. This section is naturally

divided into two reaches—Cairo to Red River Landing, or Old River, and from there to the Gulf.

Mr. Coleman's estimate that the river, from Cairo to the Gulf of Mexico, has lengthened about 75 miles since 1882 is too great. In 1882, the length of the river from Cairo to the Gulf was given as 1,060 miles; and the 1927 Special Report of the Mississippi River Commission gives its length as 1,081 miles, showing a lengthening of 21 miles between 1882 and 1927. Cut-offs cause violent changes in local slopes and velocities and disturb the regimen of the river for many miles above and below so for a number of years efforts have been made to prevent cut-offs.

Estimates made in 1892, from surveys covering a period of ten years, showed the average amount of bank erosion to be about $9^1/_2$ acres in area, with a depth of 66 ft. per mile of river. Therefore, the total for the river between Cairo and Donaldsonville, La., is annually 1 sq. mile by 860 ft. in depth. Most of the material dumped into the river by caving banks is deposited a short distance below where it originates. That very little of this material is carried to the Gulf is evidenced by the fact that the amount of silt brought into the lower river from the tributaries is approximately the same as that carried into the Gulf. About 165 miles of caving banks have been stabilized by revetment work, which is being extended each year, although several hundred miles of unprotected banks still remain.

Caving banks and a shifting channel have been a continuous menace to levees and other structures along the river. Therefore, with all the banks stabilized and the river held in a fixed position, the force of the current, which is now expended in tearing down the banks and moving the material to build points and side and middle bars, would then be expended in scouring the bottom. Also, the hydraulic radius of the channel would be increased, the velocity of flow accelerated, the water surface for a given discharge lowered, and the problems of navigation and flood control greatly simplified.

Many observations recorded by the Mississippi River Commission confirm Mr. Coleman's statement that channel deterioration is caused by crevasses and outlets. All outlets except Old River have been closed. But deposits formed in the main river, opposite and below this outlet, have choked the channel to such an extent that the flood plane for a discharge of 1,500,000 sec-ft. was raised 9 ft. between 1882 and 1927.

Prior to 1927, levees were depended upon for controlling Mississippi floods, as it was not believed that the flood of 1912 would be exceeded. However, the flood of 1927 caused a realization of the impracticability of confining a maximum flood between levees, and it was concluded that some means must be found to reduce flood elevations in the river. Many suggestions were offered, but most of them were found to be impracticable. The diversion of tributaries, for instance, was found to be too costly in proportion to the benefits.

Surveys and studies concerning the feasibility of reservoirs have been conducted since the 1927 flood, but no definite conclusions on the subject have been reached, except that the cost would be excessive as compared with that of floodways. Reforestation on a large scale might, to a limited extent, reduce run-off. However, it appears that, although reforestation may be advantageous as a conservation measure, it would have but slight effect as an aid in flood control. In 1844, long before the forests in the upper Mississippi or Missouri valleys had been disturbed, the gage at St. Louis showed a flood reading 3.4 ft. higher than any that has occurred since.

Clearing the land between the river and the levees would have some effect in lowering flood heights, because of the increased velocity of over-bank flow. However, it has been concluded that the cost of clearing and maintenance would not be justified by the benefits derived.

The plan finally adopted for flood control provides for somewhat higher and wider levees and for floodways and spillways to keep the super-flood from rising above predetermined elevations. Detailed studies are being made at the U.S. Waterways Experimental Station, at Vicksburg, in connection with field studies, of caving banks, the probable effect of cut-offs, silting, seepage through and under levees, and other features relative to river and flood control.

Whether or not any modifications of the adopted project may be made will depend upon these studies and experience.

CHARLES H. WEST, M. Am. Soc. C.E.
Member Mississippi River Commission

Greenville, Miss.
March 21, 1931

Nature's Plan for Flood Control

TO THE EDITOR: The excellent paper by Mr. Coleman, in the February issue, prompts me to contribute a few thoughts on the much-mooted subject of reservoirs and retarding basins for flood control on the Mississippi River.

It does not appear to be generally appreciated that nature has endowed this river with a remarkably efficient set of retarding basins, considering the fact that they are not provided with controlled outlets. I have reference to the backwater areas in the lower Boeuf, Tensas, Yazoo, St. Francis, and White River basins. These backwater areas, locally known as "basins," have always functioned as detention basins. We seldom think of them as such, because they lack the spectacular aspects and engineering romance of basins controlled by costly high dams, and partly because they do not happen to lower great flood stages below the arbitrary levee heights set by man.

Their retarding action, nevertheless, has a material reducing effect on Mississippi River flood stages. Although their average depth of water may be small when compared with the standards set by retarding basins, such as were built in the Miami River Valley in Ohio, the areas within them available for the temporary storage of flood waters are very large. It would be impracticable, except at prohibitive cost, to replace these basins or to duplicate their action by means of either artificial detention basins or storage reservoirs.

As is well known, retarding basins or reservoirs for flood storage, in order to be of maximum benefit, should be located on, or immediately adjacent to, the stream along which protection is needed; and the location of the basins along the Mississippi is exceptionally favorable in this respect. The Tensas Basin is the largest in point of capacity and, next to the new system of levees, will probably be the most important single factor in the control of excess flood waters of the Mississippi. Its bottom is, for the most part, covered with timber and brush, which obstruct the flow within the basin, thus promoting the retarding qualities of the basin. How thorough this action is may be judged from the fact that, at the crest of the 1929 flood, the hydraulic gradient in this basin, computed from observations on gages spaced over a distance of 56 miles, was only 5.5 ft., or

about 1 ft. in 10 miles. Water velocities in the wooded areas are rarely as high as 0.8 ft. per sec.

So apt is Mr. Coleman's review of the situation that it banishes the often-expressed belief that one who lives a long time in close contact with a big problem cannot hope to get a good perspective on it. His attitude toward the present plan for control, as expressed in the last paragraph of his paper, strikes a new keynote, which, I trust, will commend itself for earnest consideration to those who appear overinclined to criticize.

GERARD H. MATTHES, M. Am. Soc. C.E.
Principal Engineer and Chief of the Hydraulic Division, U.S. Engineer Department

Norfolk, Va.
March 13, 1931

Wind Forces in Tall Buildings

TO THE EDITOR: The article by Mr. Balcom, in the March issue, makes me feel that congratulations are certainly due the architects and engineers of the new Empire State Building for having worked together so harmoniously to produce a building which is both effective in its architectural planning and well adapted to good structural design. The arrangement of the service area in the interior of the tower resulted in a well lighted, well arranged space all around the exterior, and the deep bracing desired for both rigidity and economy is carefully concealed in permanent partitions throughout the service area. Of course, conditions will not always permit of such ideal arrangements, but they are certainly something to have in mind and to strive for in the early conceptions of a building.

Descriptions of the early placing of the contract and the careful scheduling of the time requirements for the receipt of structural drawings bring out very clearly the time-saving element in such planning. If it had been necessary to complete the structural design of the building before the placing of the steel contract, there would no doubt have been a loss of many months' time. Although I sympathize with the steel fabricators who have attempted to require complete plans and information before submitting bids, I still feel that they should endeavor, where possible, to work toward overcoming the loss of time, which is inevitable on such a project, if complete information before bids is required.

It is interesting to note that the distribution of wind shears to the several bents in the building was in the ratio of their resistance value. Under the form of analysis used, the shears in the interior panels around the service area were no doubt considerably greater than in the outside panels which come in the rentable part of the building. The ability to use deep bracing in these interior bents without inconvenience to the occupants of the building is most fortunate. From looking at the typical plan for the upper stories and considering the bents which run in an east and west direction, it is evident that the deep knees were not used in the center panels of the building, as this forms a main passageway. If the same system of analysis were used in an east and west direction as in a north and south direction, this must have resulted in the carrying of very heavy shears with some shallow type of connection. Owing to the great d pth of the building in this direction, however, this was, of course, not nearly as serious as would have been the case if the same thing had happened in the north and south bracing.

It is interesting to note the provisions which are being made in the building for the measurement of wind forces and their effects on the frame. With a correctly proportioned frame, these should give an enlightening check-up on features of the building which are ordinarily neglected in wind design. However, it seems to me that, at the present time, the greatest advance in wind bracing must be in the development of correct theory. The multiplicity of shapes and exposures of buildings with the accompanying idiosyncrasies of wind action in their neighborhood, will make the gathering of useful data tedious. The maximum winds occur only at irregular and widely spaced intervals, so that the opportunity to obtain just the data wanted will seldom occur. I feel that as long as the engineer can be satisfied that he has a reasonably safe assumption as to maximum wind pressure for design purposes, the correct development of theory is the most likely means for obtaining better wind designs. The comparative cheapness of good bracing does not make it imperative to assume maximum pressures lower than those that are now commonly used, particularly if correct theoretical analysis results in the use of deep and effective types of bracing, where it is possible to incorporate them without injury to the architectural layout of the building.

N. A. RICHARDS, Assoc. M. Am. Soc. C.E.
Vice-President, Purdy and Henderson

New York, N.Y.
March 10, 1931

Progress in Skyscraper Construction

TO THE EDITOR: The buildings described by Mr. Balcom and Mr. Spurr in the March issue of CIVIL ENGINEERING, that is, the Bank of Manhattan Building and the Empire State, are landmarks in the progress of skyscraper construction because they have been designed for stiffness. Previous to this time, all towers have been designed to resist an assumed wind load within certain allowable unit stresses. Now, for the first time, we have buildings designed to stand an assumed wind load within certain allowable deflections.

In both these examples, it may be said that the mathematical problem of design, as such, has been successfully solved. Each apparently has very nearly the vibration frequency which corresponds to its theoretical stiffness in relation to its mass. What we need now is the test of experience to show whether the allowable deflections were correctly chosen with regard to the human nervous system. Also necessary is a study of such factors as amplitudes, wind pressures, tilting of floors, and column stresses, all carried out simultaneously in order to check up on the theory in detail and to get a more accurate idea of the actual behavior of the buildings in action.

On completion of these two towers, I believe that the profession is prepared to develop a rational theory, with well grounded empirical constants, which will permit the engineer to undertake with confidence any higher towers that are likely to be built for some years to come.

DAVID CUSHMAN COYLE, M. Am. Soc. C.E.
Designing Engineer, Gunvald Aus Company

New York, N.Y.
March 10, 1931

The Civil Engineer and City Planning

SIR: The article by Mr. Knowles, in the March issue, is instructive. For city planning, the head should be either a civil engineer, who has had an architectural education, or an architect, who has had a broad engineering education. At any rate, responsibility must always be centered in one man, who may have as many assistants as the scope of the work requires.

However, the work of city planning must reach further back than mere designing, and it must include a plan for raising funds on a scale commensurate with the plans. Usually the tax budget is relied upon for that purpose, with the result that hardly any city planning can be done without getting the city in question deeply in debt and permanently saddling it with high taxes.

We should take an example, in this particular respect, from city planning in the Central European cities in the past century, notably Vienna. The most important problem connected with making new plans for this city was finding the money for its financing. The lands, originally occupied by moats and buildings of little value, were leveled and laid out in wide streets, connecting with the Ringstrasse and built up with handsome shops and residences. Then, when the great city beautification plan was really completed, it was not only all paid for from the sale of the land, but there was a surplus of over 20,000,000 gold kronen ($4,000,000) for further improvements.

Can we hope for any such planning for cities in the United States? We shall find the first answer to be "No," because of the archaic real estate laws which have not been changed in any notable way since the country was settled and land for the cities and towns was chopped up into small pauper lots of 25 by 100 ft. The acquisition of this kind of land is everywhere exceedingly costly, as a horde of speculators, lawyers, and officials depend for their living on this complicated and costly procedure of getting title for land. Time-worn notions, anchored in law, about excess condemnation add to the trouble and cost.

The Torrens Law, which originated in Australia, was tried by some American cities, but largely with poor results because of the resistance offered by the interests that depend for a living upon real estate speculations.

The first requisite for thorough planning of American cities would be laws, similar to those of Central Europe, for the absolute right of cities to acquire at their discretion and at a just value any real estate wanted for public purposes. Until this is done, the tremendously high cost of real estate will remain the greatest obstacle of city planning.

The next great obstacle in planning American cities will be found in the artificially high wages of the building trades. All of these are unionized and have contrived, with the aid of politicians, through class legislation, to make public work more costly than other kinds. A reform should be created through modern organization of the building trades, which should be recruited from the white-collar workers, of whom our schools are producing a tremendous surplus resulting in low wages for them.

From this class of young men there could be recruited, along the lines and traditions of the old guilds, a modern organization of city builders with apprentices, journeymen workers, senior workers, foremen, and masters, with certain just rules for the conduct of activities, high-class workmanship being the goal of distinction. The beautifying of our cities and the building and maintenance of durable fireproof homes would be the one field in which there would be no over-production. This enterprise would, however, produce for everybody lower living costs because of lower rents and lower insurance. At least this is the effect already observed abroad. Also, it would create urban conditions in accord with the true spirit of progress, under the leadership of the civil engineer and architect.

GUSTAV LINDENTHAL, Hon. M. Am. Soc. C.E.
President and Chief Engineer,
North River Bridge Company
Jersey City, N.J.
April 10, 1931

Engineers Furnish Basic Data for Planning

SIR: The paper by Mr. Knowles, in the March issue, shows sound judgment and realization of the possibilities for the engineer in planning the city of the future. In planning, as in all vocations in life, we are continually breaking new ground, traversing new paths, and facing in new directions. The only constant factor is the terrain. Therefore, as a basis for planning, accurate and comprehensive control surveys, supplemented by topographic maps, are imperative. The engineer must be the pioneer on the job and prepare these basic data in order to visualize and plan for the needs of the future.

Perhaps the engineer has much to learn from the architect and the landscape designer in the application of esthetics to city planning. Although this opinion is reasonable, it should, in fairness to the engineer, have further consideration. The engineer has never been altogether lacking in these esthetic qualities, but his plans or designs were often the result of circumstances, in which his vision in this art of planning was not permitted to develop. It is understood that the architect and the landscape designer deal with facts, but perhaps to a lesser degree than the engineer. For, while the capable engineer deals primarily with the basic facts affecting construction, a primary requisite to the practice of these other professions is the ability to visualize and to promote beauty of design.

The reason why far-sighted plans are shelved is not always the lack of public funds, but is, at least sometimes, the result of the fact that the planner has not based his designs on accurately prepared surveys and estimates that would seem reliable to the public, but has instead exercised his individual imagination too strongly. Regardless of the number of architects, artists, landscape designers, or consulting engineers employed by a technical, financial, or political organization, their work is valueless, from the standpoint of planning for the future city, until they realize the meaning of "facts" as understood by the engineer.

The proper procedure in planning begins with the control or foundation survey, showing the facts as to existing conditions. Some of these conditions are man-made, and others, of course, involve the natural factors which man has had no part in forming. After these have been considered, the planner, whether he be engineer, architect, or landscape architect, is then free to use his own special talents in design.

To the author's accusation of lamentable unwillingness, on the part of engineers, to spend money for esthetic purposes, exception can be taken. It was not so much their "unwillingness" that brought about this

status of the profession, as it was public opinion. The desire for such improvements was not stimulated in the past by the obvious need for them as it is at the present day. This fact, together with the lack of public funds, forced the engineer to make his plans fit the immediate requisites, rather than his own idea of enjoyable potentialities. If proposals for major improvements that are common today had been presented for approval fifteen or twenty years ago, the public would have been positive that the engineer recommending them was mentally unbalanced. The public could not then see the value of the so-called necessities of today, and esthetic considerations received even less attention. Now public opinion has changed, but even yet people are not greatly concerned with artistic designs. On the other hand, bond issues for the protection of public health—such as water and sewer systems—usually meet with ready approval. With these actualities in mind, it is felt that the engineer of the past was handicapped to such an extent that his esthetic tendencies were not allowed expression.

To sum up, planning for the future city should have its beginning in engineering facts. Upon these facts—precise control, cadastral and topographic surveys—should be based all studies and estimates, from which should be developed the final composite plan. Practicing this coordination of facts with beauty in ultimate design, we, as engineers, shall realize our logical and proper place in the planning profession.

URIE N. ARTHUR, M. Am. Soc. C.E.
Chief Engineer, Department of City Planning

Pittsburgh, Pa.
March 13, 1931

Beauty Important in City Planning

DEAR SIR: I heartily endorse all that Mr. Knowles said in his article in the March issue and am greatly pleased with the newly awakened interest of the civil engineering profession in the great movement for city planning along the broad, practical lines embraced in the frequently repeated phrase, "Health, Safety, and General Welfare." Mr. Knowles covers all the different aspects of the subject of city planning and shows how the field requires all that is best in civil engineering skill. The civil engineer is essential in such work, as no permanent point, line, curve, or elevation can be established without his aid.

Realizing the great importance of city planning, Mr. Knowles invites a full discussion of the subject and suggests to every thoughtful engineer the necessity of combining the treadmill part of his work, such as laying out streets, installing water works, and building bridges, with the additional duty of meeting the newer demands for all that tends toward the esthetic and beautiful.

Certainly we must realize that the day of low cost considerations, the bugbear of every civil engineer, has passed. While it is true that many of us have been trained in the hard school of making ends meet, we are now face to face with the truth of Mr. Knowles' statement that, "Public money is more wisely spent in making public work properly attractive, than it is in buying new property simply for the purpose of adornment and recreation." The truth of this can easily be ascertained by visiting some of the recently improved water courses in rural districts, whose banks have been transformed into wonderful recreational units, and contrasting their surroundings with other districts where the sources of water supply are nothing more than unsightly open ditches, or meandering lines of pipe.

To me, the outstanding thought in Mr. Knowles' paper is that it is a pressing necessity for the civil engineer who would keep abreast of the times, to look beyond the hard and fast rules of his own calling to a union with all the professions that are capable of advising on matters of public safety, health, comfort, prosperity, beauty, and general welfare.

Sooner or later, it will be possible to get all, or at least a majority, of the engineering profession who believe in progress to unite in giving us cities and towns that will be beneficial to all the citizens.

A. J. HAWKINS
City Engineer

Birmingham, Ala.
April 1, 1931

The Esthetic Element in City Planning

TO THE EDITOR: The paper by Mr. Knowles, in the March issue, is of considerable interest. Planning, in its essence, is establishing relationships. It is a process in which the human mind is called upon to function both analytically and synthetically. This is the most difficult task that human beings can set for themselves. One cannot analyze with any accuracy or with even a small measure of success, (1) if one's mind is not flexible, (2) if one is prejudiced, (3) if one is not healthily skeptical, (4) if there are blind spots which prevent recognition of conditions and factors inherent in the subject matter that is to be analyzed. One cannot synthesize with skill and imagination, (1) if one is not flexible of mind, (2) if one is afraid of theorizing, (3) if one is not willing to experiment, (4) if one is unaware of the difference between trained imagination and "imaginitis," (5) if one is afraid of the disapproval of the literal minded.

When Mr. Knowles says "the engineer should appreciate the fact that he has much to learn from his esthetic friends, the architect and the landscape designer," I suspect this is an admonition to respect the esthetic element which is dominant in their work. If, however, the implication is that the mature and precisely trained engineering mind should learn, by observation, how to incorporate esthetic factors into a more balanced and more fully rounded conception, then I am urged to doubt its feasibility. The works of the greatest engineers display consideration for esthetics. But, as I see it, esthetic appreciation and training and the understanding of esthetic principles in the graphic and fine arts are not likely to be acquired through some purely intellectual process of a mind which has not been subjected to their influence during the so-called "formative years." I hold that the training of young men to be only "intensely practical" engineers is a biased training, just as I hold that the training of young men to be imaginatively skillful designers is futile if this training does not produce the ability to translate their imaginative conceptions into practical and usable form. In this latter statement, I mean to leave room for the idea that the creation of beauty itself has never been, and can never be, a useless activity.

I have known civil engineers who looked upon esthetic factors as if they were strange and rather pitiful aspects of superficial ornamentation. I have known others of whom I should be willing to say that they had come into the world with a blind spot where esthetic impulses

are ordinarily centered. But many civil engineers whom I have known have, from my point of view, suffered because their education and life experiences have allowed their artistic potentialities to be neglected, with the result that those impulses have either atrophied or remained undisciplined and uncoordinated with the other elements of their personalities. Is it too late to expect such men to do for themselves what they should have been helped to do when they were still young? I suspect it is; but I see no reason why, as Mr. Knowles suggests, they should not respect those of their associates who are differently endowed. And, above all, I see no reason why they cannot, as a mature intellectual process, assign to the esthetic element in city planning its proper position as a fundamental and controlling one. Nothing in the way of physical public improvement can be done that is not appraisable as to its esthetic content and quality. The result will be judged, good or bad; and it will be judged by those whose training and abilities have impressed them with the significance of the laws that seem to be universally applicable in the fine arts. It is up to all of us to see that the results are worthy rather than unworthy.

I believe that the civil engineer is necessarily so dominated by an environment, in which the element of culture is minor in its extent and influence, that he is often coerced into assuming, as a protective measure, a compartmental characteristic of mind, keeping his esthetic impulses apart from any effective influence upon his so-called practical efforts to make a living or his efforts to please employers to whom cultural values or esthetic factors make no appeal. It must be admitted that, in a state of civilization in which mass production and the intricacies of the credit system are dominant phenomena, the struggle for cultural values as against dollar values has seemed to many to be a losing fight. Whether or not the fight be a losing one, it is not entirely fair to condemn an engineer whose products often show an undue dominance of the dollar mind.

FREDERICK BIGGER
Architect and Town Planner

Pittsburgh, Pa.
March 15, 1931

Model Analysis of Great Value

SIR: In their comments on my article on mechanical truss analysis, printed in the December issue of CIVIL ENGINEERING, Messrs. Lindenthal, Waddell, and Wessman assign to model analysis the purely supplementary task of providing a check on the mathematical computations. This is the natural attitude of engineers accustomed to handling work of the first magnitude, but does it reflect the view of the average designer? For structures like the Hudson River Bridge, experts to whom the mathematical computations present no serious difficulty are always available, but for structures of less importance this is not necessarily so. In such cases, model analysis is sometimes relied on exclusively, as it is so much simpler than other methods and admittedly accurate enough in that it is acceptable for checking purposes. The recent case of the foundation of the Albany Telephone Building is an illustration in point, as its design is based solely on model analysis. For an account of this see *Engineering News-Record* for November 27, 1930.

In regard to the further comments of Messrs. Waddell and Wessman, it should be noted that axial stresses may be determined from the model as simply as are the reactions. In gaging the model members, as is always advisable, their deformation, $i_1, i_2, \ldots$, under an arbitrary force unit axially applied, is measured and compared. The same force unit is next applied at a panel point of the assembled and fully supported model, causing it to deflect, the measured axial deformation thereby produced in the members being $k_1, k_2 \ldots$. Denoting by $l_1, l_2 \ldots$ the length of the model members and by E the modulus of elasticity of steel, it is obvious that

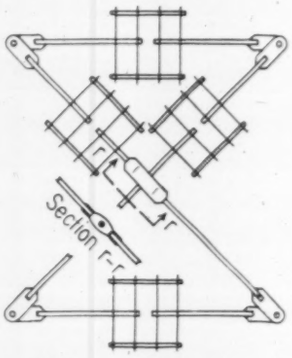


FIG. 1. DIAGONALS NOT CONNECTED

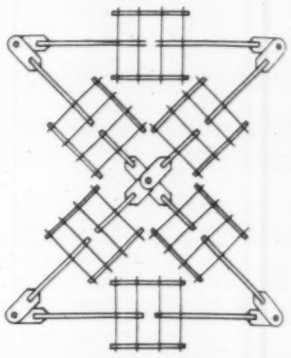


FIG. 2. DIAGONALS CONNECTED

if the structure were to be deflected by a proportional amount, the stress in a member n would be $\frac{k_n}{l_n} E$, the panel load producing the deflection being $\frac{i_n}{l_n} A_n E$, where A_n is the area of the member n. For a given panel load P, the stress is accordingly $\frac{k_n}{i_n} \frac{P}{A_n}$. After the stresses in member n due to the other panel loads have been determined in a similar way, the resulting stress is found by algebraic summation.

In my article, a structure of the most elementary type, with single diagonals, was chosen as an example in order to simplify the mechanical work. No difficulty would be encountered, however, if the model were to contain double diagonals. Their arrangement may then be either of those shown in Figs. 1 and 2. Where members are still more cramped, they may be turned 90 deg. about their own axes, openings having been made in the board to accommodate them. On this score, there would seem to be no reason why the method could not be applied to structures like the Hudson River Bridge towers. The question where to place the suspension cables might have been satisfactorily investigated by means of a model of the towers made in one plane only.

ANDERS BULL, M. Am. Soc. C.E.
Assistant Engineer,
Board of Transportation

New York, N.Y.
March 16, 1931

The Master Plan and Subdivision Control

DEAR SIR: The article on "Supervised Regional Expansion" by Mr. Greensfelder, in the January issue, is noteworthy for its comprehensiveness of thought and for the fact that it illustrates the interdependence of different aspects of community and regional existence. Our laws, methods, applications, and understanding, in

regard to community and regional planning and development, are constantly advancing and becoming more useful. In this mobility, subdivision regulation and its application as a method of control after broad planning is receiving recognition and is perhaps worthy of some amplification.

Frequently in the past—probably because of specific assignment by law to the planning commission—platting control has been conceived, not alone as a means to an end but, indeed, as a complete fulfillment of the planning idea. In most instances now, enabling acts condition the exercise of such control upon the prior development of a master plan, or at least of the main thoroughfares for the region, in which such control is to be applied. After the master plan has established the general design, the fitting in of the individual and more detailed parts then becomes a matter of control. Such control should be aimed to strike a balance between the extent of authority necessary for realization of the basic plan and the encouragement of initiative and originality in subdivision design. This suggests a variety of thought on the subject and numerous points of view for consideration.

The community and regional plan will, among other things, establish the use of property, including public reservations. Residential areas will be designated and this, at first thought, would seem to simplify the problem of directing subdivision development. It would appear that minimum standards might be established and that enforcement of compliance with these standards would satisfy the essential elements of control. However, constructive supervision must recognize the necessity of a much broader conception of the control idea. For example, it is common knowledge that many cities have a great excess of subdivided property and, while it is not the province of a governmental body to attempt to prescribe by direct action the law of supply and demand, much may sometimes be accomplished through helpful suggestion. Again, perhaps the general type of development proposed, while it would be appropriate in another part of the city or region, is not the type desirable for the particular location for which it has been designed. In such instances, advice of the proper kind may prove effective. Also, while the planning commission should under no circumstances dogmatically assume the rôle of designer, the preparation in some instances of a detailed street plan, in addition to the general thoroughfare plan, is justified.

This applies particularly where coordinated development of an area is difficult because of the number of individual tracts under separate ownership. In such instances, a comprehensive design, ignoring property lines, is a straightforward and effective method of securing the cooperation of property owners and subdividers in developing a coordinated layout. A similar procedure may sometimes be effective where subdivisions have been improperly designed prior to inauguration of control. In many of these, development has not progressed to such an extent that rearrangement has become impossible; and the initiative of the commission in accomplishing such improvements would result not only in betterment to the community, but also in greater usefulness and increased values in the subdivision.

These thoughts are not expressed with the idea of unduly emphasizing the importance of subdivision control, but rather to suggest its significance and what it may include in practical application. Essentially, it is an administrative tool after the community and regional pattern has been established. The master plan must come first, and all elements may receive consideration in greater or less degree, depending upon circumstances. But for a planning body to attempt supervision of subdivisions without that understanding which must come through the study and thoughtful consideration incident to the conception of the community and regional plan, is not only ineffective but may also be harmful.

In his paper, Mr. Greensfelder has aptly indicated the relation of land subdivisions to the thoroughfare and other plans, and has given their regulation regional significance as an element in the general planning scheme.

MORRIS KNOWLES, M.Am. Soc. C.E.
President, Morris Knowles, Inc.

Pittsburgh, Pa.
March 17, 1931

Movable Bridge Design Correction

TO THE EDITOR: In my article on "Movable Bridges," in the April issue of CIVIL ENGINEERING, I note that an error has been made in the course of setting up my manuscript in print. On page 597, the sentence beginning in line 21 of the right-hand column should read, "The proper combinations are Case 1 alone, Case 1 with Case 3 [not "Case 2 with Case 3," as printed,] Case 1 with Case 5, and Case 2 with Case 4."

As the combination of these various cases of loading is of great importance, I feel that this correction should be called to the attention of readers.

OTIS E. HOVEY, M. Am. Soc. C.E.
Consulting Engineer,
American Bridge Company

New York, N.Y.
April 10, 1931

Railroads Are Indispensable

SIR: It seems to me that Colonel Jonah, in outlining in the January issue the principles upon which the various agencies for transportation may be coordinated, has had in mind chiefly the results of past experience, which are not applicable to present conditions and future needs.

Coordination of terminals is merely incidental to that of the transportation agencies themselves. Before principles governing coordination of present and future transportation agencies can be intelligently formulated, it is essential that future public policies, with respect to such agencies, be more definitely outlined.

The predominating public sentiment concerning the progressive capture, by more recently developed agencies, of the passenger and freight traffic previously supporting the railways, is similar to that in existence when the advent of the railroads began to eliminate stage coaches, covered wagons, river steamboats, and canal boats.

Development of the internal combustion motor has been responsible for the organization of highway traffic like that of the railways, by private capital but, unlike the railroads, on routes provided and maintained at public expense. An artificially created sentiment is now attempting, at heavy Government expense, to bring back privately operated river steamboats and canal boats, on rivers canalized, dredged, and otherwise maintained at public expense, and on canals owned and maintained through taxation.

It is obvious that neither these agencies nor those of the air can take the place of the service rendered

by the railways in transporting those persons who cannot endure the hardship of travel by "bus" or private conveyance, in handling parcel post mail, heavy express or freight commodities—such as livestock, grain, pig iron, ore, coal, stone, brick, concrete aggregate, cement, steel shapes, and heavy machinery—or in transporting military stores and troops, where expedition is the essence of the service.

It is needless to illustrate for engineers or an informed public, the utter impracticability of doing without trunk-line railway transportation. It is sufficient merely to point out the multiplicity of units which would occupy the highways, and the heavy loadings and weight of freight-carrying units that would involve multiplication of traffic lanes, more enduring hard-surface construction, stronger bridges, and a consequent expense that is at present incalculable.

It is inconceivable that the American public will not be aroused to action when it realizes that letting nature take its course will force the 22 billion dollars now invested in the railroads—and forming the basis of vast investments in insurance and endowments—to be rendered unsafe and what it represents either destroyed or taken over and operated by the Government with revenue raised by taxation.

I feel that the logical thing to do is to regulate impartially all transportation agencies, preserving their private operation on a universally equitable basis, and prescribing living rates and an adequate return on such types of traffic as each agency may be best adapted to perform. The solution does not lie in any proposal for absorption of public highway transport by the railways nor in inaugurating ruinous competition, but it presents a problem for the engineering profession and a wonderful opportunity for public service.

HUNTER MCDONALD, Past-President, Am. Soc. C.E.
Past-President American Railway Engineering Association

Nashville, Tenn.
February 23, 1931

Changed Conditions of Winter Construction

TO THE EDITOR: Some seven or eight years ago it was my privilege to serve on Mr. Hoover's committee on seasonal occupation in the construction industry with Mr. Taylor, author of the paper on "Twelve-Month Construction," published in the January issue of CIVIL ENGINEERING. We both brought out the point that it is custom, not climate, which prevents winter construction. Tradition is strong. But even bears learn from experience, and those in the zoo stay out where they can be seen all winter. We might follow their example and adapt our habits to modern conditions.

I have often fancied that perhaps the actual cost of construction in winter is not so much greater than in the heat of summer. Bricklayers do not work very fast when it is 105 on the scaffold, and sometimes structural steel workers pause to call the water boy.

It is simply a question of overcoming traditional obstacles. With modern power equipment we can construct economically during the winter season. Power shovels easily excavate frozen material which a few years ago could have been moved only at considerable cost. By using electric hoists and heating concrete materials we can construct safely the concrete being heated to about 75 deg. and carried from central plants through the streets to the job.

While the mortar in brickwork or concrete must be taken care of, the rest of the construction takes care of itself. A little canvas or cloth will keep the wind out of structures. Manufacturers of heating devices are becoming aroused to the opportunity and are putting in blowers and temporary heating plants, which make some building work considerably easier than it used to be. From the viewpoint of the owner, as well as from that of the contractor, who has a large amount of capital tied up in power equipment, it pays well to continue work in winter.

Early letting of construction work is very helpful. It used to be the habit around St. Louis not to award construction contracts until May or June, which meant that work did not start until July, was not finished during the open season, and had to be left unfinished all winter. Since this matter has been called to the attention of highway and railway engineers, contracts are being awarded in January. The Missouri State Highway Department awards a large portion of its work in January and February. Then contractors have time to organize their men, buy their equipment, and get ready to start as soon as the frost is out of the ground. About March 15 they are at work and, to the satisfaction of the residents along the highway, construction is completed before the next winter.

In future, I am inclined to think that more paving will be done in winter, when there is a smaller volume of traffic to be provided for. Considering the cost of detouring, this would seem an economical method.

A. P. GREENSFELDER, M. Am. Soc. C.E.
President, Fruin Colnon Contracting Company

St. Louis, Mo.
April 4, 1931

A Notable Amateur Organization

SIR: In a short article in the April issue of CIVIL ENGINEERING, under the heading of "Keeping Society Contacts," one of the accomplishments of the American Radio Relay League is described. From the casual mention of this organization, one might think that it was of insignificant character whereas, in reality, it is the largest amateur body of any kind in the world.

With a total membership of about 17,600, it has representatives scattered broadcast over the country. At the same time, it maintains contact with similar organizations in other countries through the International Amateur Radio Union. It is interesting to note that the number of licensed amateur stations—a total of about 19,000—compares with about 600 commercial broadcasting stations.

The exploit mentioned in CIVIL ENGINEERING is only a normal occurrence. The most outstanding feats of the league were its original establishment of two-way trans-Atlantic communication and its work in connection with the Florida hurricane of 1926, the Mississippi and New England floods of 1927, and the California dam break and second Florida hurricane of 1928. On five separate occasions the league network has rendered signal service in maintaining communication when railroad wires went down.

J. H. GRANBERY, M. AM. SOC. C.E.

New York, N.Y.
April 13, 1931

A Comment on the Eads Bridge

TO THE EDITOR: The interesting article by Mr. Bowen, in the January issue, on the use of caissons—particularly open ones—in St. Louis subsoil brings to mind the fact that James B. Eads, builder of the epoch-marking Eads Bridge at St. Louis in 1873, had planned to use an open caisson in the construction of the river piers. In his report to the Illinois and St. Louis Bridge Company in 1868, he described his plan. The caisson was to be of iron plates sunk to bedrock through the sand which was to be excavated by "steam machinery." The pier was to be built inside of the caisson upon a floating cofferdam, the bottom of which was to be of squared timbers, 2 ft. thick and thoroughly caulked. The timbers were to remain permanently between the top of the concrete bed prepared upon the bedrock and the bottom of the masonry. In defense of the permanence of the timber, Mr. Eads cited the fact that wooden piles driven into the bottom of the Rhine by the Romans had been found sound after 2,000 years.

This was Mr. Ead's original plan. In 1869, however, after returning from Europe, where he had studied at first hand the pneumatic process of sinking caissons, he abandoned the open method in favor of the pneumatic, much to the regret of Colonel Flad, his assistant. By making marked improvements in technic and particularly by his invention of the sand pump, Eads was able to sink the east abutment to the depth of 109 ft., $8^1/_2$ in., a new record at that time and one which has not been greatly exceeded since. Results showed that the pneumatic method was far superior to the open caisson method, and Mr. Eads estimated the saving at $200,000.

WAPREN RAEDER, Assoc. M. Am. Soc. C.E.
Professor of Civil Engineering
University of Colorado

Boulder, Colo.
February 28, 1931

Cold-Weather Concrete Placing

EDITOR: I enjoyed Mr. Taylor's article on twelve-month construction in the January issue. As is generally known, special efforts have been made during the past year to speed up construction on public works, such as concrete roads, one result being that up to the end of August the yardage of concrete highway pavements awarded exceeded that constructed during the same period in 1929 by 23 per cent. All concrete paving work, including highways, streets, and alleys, exceeded the output for 1929 by 7 per cent.

The precautions to be taken with concreting operations in cold weather and the equipment required to provide protection for fresh concrete are so well known that no misgivings need be entertained. In this connection we might well take a hint from Canada, where winter concreting operations are a regular part of construction work. Winter seasons there are so prolonged that no one thinks of stopping for cold weather, and winter concreting operations are not even a problem. The work is protected by methods well known to all builders.

The mistaken impression prevails in the minds of many that winter concreting must be carried on at the sacrifice of ultimate strength in the concrete. On the contrary, the opposite is nearer the truth. This statement is amply verified in the 7-day and 28-day concrete strengths reported by Robert C. Johnson in the leading article in the October 1930 issue of *Concrete*, pages 13 to 16.

Some 400 cylinder tests, made during the construction of a large building in Kenosha, Wis., show that during the period when the enclosure was heated—from October 9, 1929, to February 21, 1930—the strength of the concrete placed during the heating period was not only higher, but also more uniform than that of concrete placed before and after. The reason is not hard to find. The concrete placed during the heating period was placed under conditions that approached those of the laboratory.

NORMAN M. STINEMAN, Assoc. M. Am. Soc. C.E.
Structural Engineer, Portland Cement Association

Chicago, Ill.
April 1, 1931

An Unsafe Method of Sewage Disposal

EDITOR: Since the publication of Mr. Knowles' admirable paper, "Western Pennsylvania's Engineering Progress," in the February issue, the Rivers and Harbors Committee of the Chamber of Commerce of Pittsburgh has adopted a resolution calling for storage reservoirs in the Allegheny and Monongahela Rivers that will insure adequate pure water for navigation, and for mercantile, and domestic uses at all times. The Board of Directors of the chamber has endorsed the resolution and urged President Hoover, Hon. Partick Hurley, Secretary of War, Maj.-Gen. Lytle Brown, Chief of Engineers, and Senators and Representatives from Pennsylvania, to take immediate action.

The Pittsburgh Flood Commission has for many years urged the navigators on the Rivers and Harbors Committee to report favorably on storage reservoirs at the headwaters. Now they realize the importance of the storage of flood waters. The drought of 1930 would have closed navigation on the Monongahela River and crippled it on the upper Ohio had it not been for the meager supply of storage waters from Lake Lynn on the Monongahela. Even with this supply, the acidity due to soft coal mine waters caused the owners of steamboats in Pittsburgh and the vicinity a loss placed at $250,000. This does not include the large loss suffered by steel industries and the owners of steel barges.

Praise is due Mr. Knowles for his courage in calling the attention of large cities to the necessity for immediate preparation of plans for adequate sewage disposal. Practically all the cities on the Allegheny, Monongahela, and upper Ohio Rivers dump their sewage into the rivers, and there was no flood sufficient to carry off the accumulation of heavy sewage in the river beds from February 1929 until April 1931.

Stern-wheel steamboats plying up and down our local streams disturb this sewerage in the bed of the shallow rivers, and it is only the sulfurous acid from soft coal mines that has prevented an epidemic. It is interesting to know that the waters of the Allegheny, Monongahela, and Ohio Rivers are the source of supply for domestic purposes.

E. K. MORSE, M. Am. Soc. C.E.
Consulting Engineer

Pittsburgh, Pa.
April 3, 1931

SOCIETY AFFAIRS

Official and Semi-Official

Advances in Society Publications

The report of the Publication Committee for 1930, signed by Harrison P. Eddy, then Chairman of the Committee, has been reviewed and ordered printed here in abstract form by the 1931 Committee. CHARLES H. STEVENS, *Chairman*

The Committee on Publications is pleased to report for 1930 a year of definite progress in all matters over which it has had jurisdiction. Its attention has been devoted in part to the determination of publication policies, with particular reference to the new monthly publication of the Society; and in part to routine matters, including the acceptance of papers and reports presented for publication, and the making of contracts for supplies and printing.

The new monthly publication, which made its initial appearance on October 1, 1930, under the name of CIVIL ENGINEERING, required the reorganization and enlargement of the publication staff, intensive study to determine editorial and advertising policies, and decisions on many technical questions as to the form it was to take. This publication has been introduced to present distinctive technical matter in a form which will be attractive to a large proportion of the members; to provide an opportunity for Division officers and for committees to present information to members, thus securing their interest and aid in the work; to provide an outlet for information relating to the administrative and educational activities of the Society; and, through the sale of space to high-grade advertisers, to supply reliable, helpful information regarding engineering methods, materials, and equipment, and to procure an income to offset the cost of publications issued under the new plan.

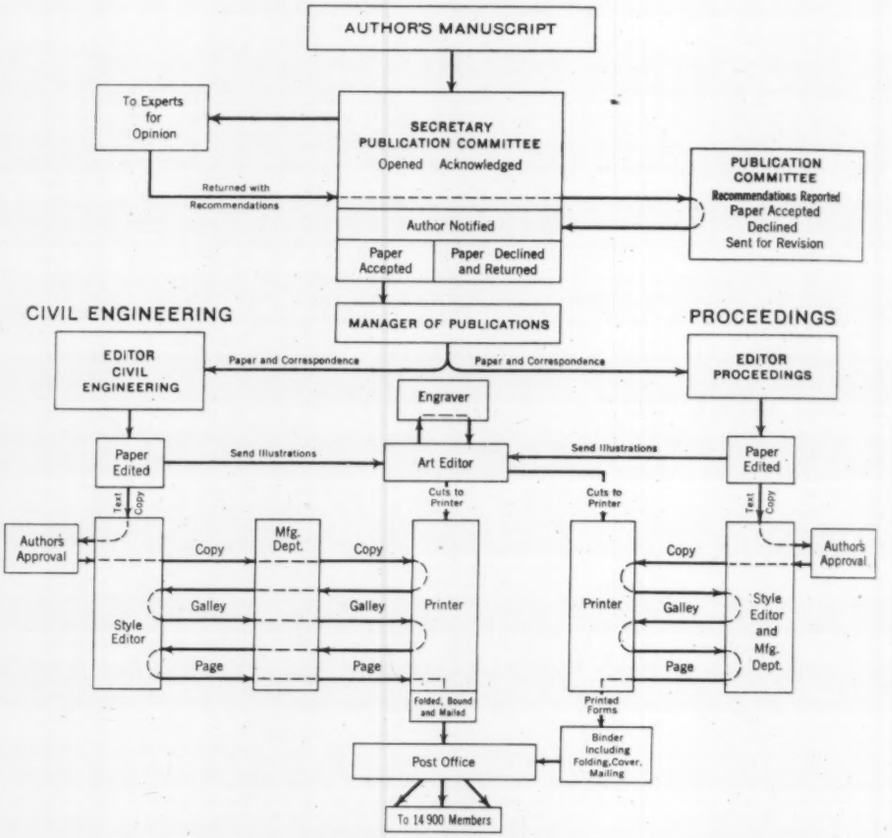
The policies for the new publication have been determined with a view to meeting the widely divergent needs of the 14,900 members in so far as practicable, and to maintaining the high technical, professional, and ethical standards which have established the prestige of the Society. Great care has been taken to avoid any possibility of an accusation that the Society has adopted a policy leading to commercialism and to a lowering of its standards. The business department will be guided by the principle that it must accept only dependable, helpful, and informative advertisements, and that the sale of space is to be solely on the basis of its intrinsic value to advertisers. Contracts for advertising space have exceeded all expectations, notwithstanding the business depression. The income from this source in 1931, it is confidently expected, will go a long way toward defraying the additional expense of CIVIL ENGINEERING. This is far better than was originally anticipated. The fourth, or January issue, contained practically as much advertising as it was considered safe to estimate at the outset for the twelfth issue.

NEW STYLE FOR PROCEEDINGS

Considerable attention has been given to PROCEEDINGS in an effort to make it a studious, concise treatment of fundamental engineering matters, both dignified and highly technical, having an appeal to members primarily interested in scientific advancement. Slight revisions were made in the style and appearance, starting in 1931, with the idea of giving increased dignity and accessibility to the technical papers and discussions which form the fundamental literature of the Society.

It is hoped that the members of the Society will approve the policy adopted by the Board, of publishing memoirs in TRANSACTIONS only, thus giving additional space in PROCEEDINGS for technical literature. The 1930 volume of TRANSACTIONS contains 1,777 pages, of which 288, or over 16 per cent, were devoted to memoirs.

A revision has been adopted in the style of printing the *Year Book*, the typography being improved to make this volume more legible and pleasing in appearance. The greatest change will be noticed in the printing of the list of members, which will be in two columns to the page instead of one.



FROM WRITER TO READER

Office Routing of Society Papers for PROCEEDINGS and CIVIL ENGINEERING

Manuals on *Lock Valves, Construction Methods and Plant, Charges and Method of Making Charges for Professional Services*, and *Charges for Engineering Services*, aggregating 287 pages, have been issued during the year

MANY MANUSCRIPTS UNPRINTED

The large volume of material available for publication in the immediate future presents an important, if not a serious problem. Among the articles in prospect are included extensive reports by Society committees on earthquakes and arch dams, a series of papers to be issued in conjunction with the Port of New York Authority, and certain Manuals which are in preparation. All this is in addition to the regular yearly schedule of PROCEEDINGS, TRANSACTIONS, the *Year Book*, and CIVIL ENGINEERING. This is the largest and most diversified program the Society has had in recent years, if not in its history.

In obtaining material for publication, the Committee on Publications has continued the policy of complete freedom of action in accepting or declining papers, discussions, and committee reports, and in editing all accepted material in accordance with the dictates of the best literary practice and the need for strict economy in the expenditure of the funds entrusted to it.

Acknowledgment and appreciation of helpful cooperation is given at this time to members who have presented papers, discussions, and committee reports for publication, and also to those who are continually rendering signal service to the Society in reviewing such papers; to the loyal Headquarters staff; and to the Society's printers; all of whom have assisted in maintaining and enhancing the reputation of the Society for high-grade technical publications.

Secretary's Abstract of Board of Direction Meeting

The Board met in the Hotel Monticello at Norfolk, Va., on April 13 and 14; President Francis Lee Stuart in the chair; George T. Seabury, Secretary; and present also Messrs. Buck, Budd, Chester, Coleman, Dusenbury, Gowdy, Herrmann, Holleran, Howe, Jacobs, Lupfer, MacCrea, Mead, Mendenhall, Morris, Morse, Nicholson, Reichmann, Singstad, Slattery, Stevens, Thomas, and Winsor.

Approval of Minutes of Board

The minutes of the meeting of the Board held on January 19, 20, and 22, 1931, were approved.

Amendment of By-Laws

Article V, Section 2, paragraphs *f* and *g*, of the By-Laws relating to qualifications required of a proposed Student Chapter were changed to conform to the rules adopted in January last.

Local Section Constitutions

Proposed amendments to the constitutions of the New York and the Los Angeles Sections were approved.

Rudolph Hering Medal

The Board gave approval to the request of the Executive Committee of the Sanitary Engineering Division that there be eligible for the award all original papers dealing with water works, sewerage, drainage, refuse collection and disposal, or any branch of sanitary engineering, which are presented before the Society in finished form whether before the Sanitary Engineering Division or otherwise.

Columbia Scholarship

Sponsorship of a scholarship, at Columbia University, valued at approximately $700 a year and to be known as the Horatio Allen Scholarship in honor of Horatio Allen of the class of 1823, Columbia, and fifth President of the Society was accepted.

This scholarship will be open to either postgraduate or undergraduate students whose records have been approved.

Division of Engineering—Economics and Finance

The constitution of this new Division as drafted and adopted at the organization meeting last January was approved.

Appointment of Secretary, Treasurer, and Assistant Treasurer

George T. Seabury, Otis E. Hovey, and Ralph R. Rumery were reappointed respectively Secretary, Treasurer, and Assistant Treasurer of the Society.

Professional Conduct

The Committee on Professional Conduct reported on four cases which were acted upon by the Board.

American Engineers in Russia

The committee, suggested at the Annual Meeting of the Society, presented a report of the conditions surrounding the employment of American Engineers in Russia, which was accepted and ordered printed in CIVIL ENGINEERING for the information of members.

Fowler Fund

The Phebe Hobson Fowler Professional, Architectural, and Scholarship Awards were discontinued.

Registration of Engineers

The Board adopted a resolution urging that, in the appointment of members of state registration boards, the local or national engineering societies be called upon to make suggestions to the end that the granting of registrations be not based upon political, partisan, local, or other exigency but solely upon evidence of technical ability and experience.

Multiple Dwelling Law Amended

Approval was given to the bills recently passed by the New York State Legislature amending the present licensing law by the inclusion of definite higher requirements for licensing engineers and amending the Multiple Dwelling Law by placing the engineer and the architect on an equal basis with respect to the filing of the plans contemplated under that act. The Secretary was instructed to communicate to Governor Roosevelt this approval and the Board's earnest request that he accord the measures his executive approval.

Joint Report Disapproved

Holding the view that the suggestion contained in the Report of the Joint Committee of Architects and Engineers, submitted to the Board last January, which proposed that there be granted special licenses, to be known as "Professional Engineer, Structural," was in effect a segregation of engineers which would contribute to jurisdictional disputes among engineers, the Board disapproved that report.

Bridge Clearances Over Navigable Streams

To the new Division of Engineering-Economics and Finance the Board recommended the immediate study of the economic factors applicable to vertical and horizontal bridge clearances over navigable streams; those practical features by which streams may be determined as navigable or not navigable and the high water basis on which the relative equitable needs of land and water transport should be compared.

Adjournment

The Board adjourned to meet on July 6 at Paradise Inn, Rainier National Park.

Appointment of Engineers on Registration Boards

With the growth of engineers' registrations, problems of efficient administration have impressed themselves on all who have studied this problem. The Society's Committee on Registration has made an intensive investigation of it. With the intention of strengthening efforts to improve the quality of the personnel of the examining boards, a resolution was adopted at the April meeting of the Board of Direction, as follows:

Whereas registration of professional engineers has now become a fact in 26 states of the Union; and

Whereas the universally expressed purpose of such registration is to safeguard life, health, and property; and

Whereas the registration of engineers should be contingent solely upon the indication of technical ability and experience and not upon political, partisan, local, or any other exigency; and

Whereas the administration of a registration law to attain this objective may be seriously jeopardized through incompetent or unethical actions of the state registration board, tending to destroy public confidence in state officers and even in the engineering profession itself; be it

Resolved that the governor or other legal appointing power, as provided in the several registration laws, be urged to call freely upon the profession through its organized engineering societies, local or otherwise, to submit to him the names of engineers eminent in their work and so minded as to contribute of their time and energy to the faithful and efficient discharge of such duties, and from among whom he shall fill any existing vacancies in the state registration board.

And be it further resolved that these resolutions be transmitted to the Local Sections of the Society with the recommendation that they take appropriate action.

Notes on the Norfolk Meeting

The Norfolk Meeting of the Society has come and gone, leaving a most happy impression of Virginia with the 437 who registered for the three-day session. The sessions on Wednesday were of general interest and were well attended. They were followed by a conference of representatives from Student Chapters and the Southern Regional Meetings Conference late Wednesday afternoon.

Thursday morning was devoted to four simultaneous sessions of the Surveying and Mapping, Highway, Sanitary Engineering, and Waterways Divisions. These sessions were adjourned promptly at noon, permitting the visitors to board an excursion steamer for an extended tour of the harbor. Nine planes from the Army's air force at Langley Field convoyed the party from the site of the Monitor-Merrimac encounter to the James River Bridge, and back to the Newport News Shipbuilding and Drydock Company. Here a visit was made to the machine shops where the Dnieperstroy (Russian) turbines are in process of construction.

The party was then convoyed to the Virginian coal pier by a squadron of Navy planes and five Marine Corps pursuit planes. After an inspection of the car-dumping machinery at the coal pier, visitors entered buses for a tour of the Naval Operating Base.

On Friday morning six buses carried visitors by ferry to Newport News and thence to historical shrines at Yorktown, Jamestown, and Williamsburg. Thoroughly saturated with the historical charm of the peninsula, the party returned by way of the James River Bridge, stopping to enjoy a vertical ride on the lift span, 151 ft. above the river.

The dinner and dance on Wednesday evening, and the informal dinner and entertainment Thursday evening were most enjoyable and rounded out a memorable meeting. The June number of CIVIL ENGINEERING will contain abstracts of the technical papers.

Generous Response to New Division

The first general publicity to the new Engineering-Economics and Finance Division was given in the March issue of CIVIL ENGINEERING, where a brief account was inserted together with a coupon for application for membership. During the succeeding month, a number of members took advantage of this opportunity to signify their interest and desire to join the Division. In all, almost one hundred names were added to the roster of the Division so that the membership as of April 17 numbers 195. The newcomer is thus showing expected vitality and will soon take a fitting place in the general scheme of Society activities.

Engineers Aid Employment

GENERAL KUTZ REPORTS FOR PUBLIC WORKS SECTION OF PRESIDENT'S EMERGENCY COMMITTEE

The Public Works Section was one of four sections into which the work of the President's Emergency Committee for Employment was divided, the other three being Community Organization, Industry, and Women's Activities. The Public Works Section was organized under F. T. Miller, of Boston, and its purpose was: (1) to influence and assist in placing under construction public and semi-public structures such as buildings, highways, and bridges; and (2) to aid in hastening similar projects already authorized, but held up or delayed by one cause or another.

The following organizations were invited to cooperate in the work of the Public Works Section, and agreed to do so:

American Engineering Council
American Institute of Architects
United States Chamber of Commerce
American Federation of Labor
Associated General Contractors of America
American Institute of Steel Construction, Inc.
Portland Cement Association
Lumber Manufacturers' Association

Each organization appointed a representative for that purpose. The American Federation of Labor, the Associated General Contractors of America, and the Lumber Manufacturers' Association, while in sympathy with the aims of the section, contributed advice intermittently, but the representatives of all the other agencies have devoted practically their full time to the work from the time the section was formed in November until the present date.

FIELD AGENCIES FORMED

As the first step in carrying out its mission, the Public Works Section undertook to compile a list of public and semi-public construction projects that held promise of unemployment relief, including those proposed as well as those authorized. To secure this information, a blank questionnaire in card form was drawn up and copies were distributed to engineers, architects, contractors, public officials, and others throughout the United States. Field agencies were created to distribute cards, collect information, and act as correspondents in the work of the section.

The American Engineering Council formed 140 field agencies, including the Local Sections of the American Society of Civil Engineers. At places where no such sections were in existence, the local sections of the American Society of Mechanical Engineers or of the American Institute of Electrical Engineers were asked to serve as field agencies; or individual members of the American Society of Civil Engineers were designated as field agents. In like manner, the American Institute of Architects used its local chapters; the U.S. Chamber of Commerce, its constituent membership, that is, the local chambers of commerce that contribute to its support; and the Portland Cement Association and the Institute of Steel Construction worked through their district engineers and other local agents.

It thus appears that there was no dearth of local representatives. But there was no cohesion among them and no plan for cooperative effort on their part.

COLLECTING INFORMATION

The questionnaire called for a brief description of the project, its estimated cost, whether proposed or authorized, and the causes of delay, if any, in connection with authorized projects. The reports called for were restricted to projects the estimated cost of which exceeded $25,000; and, in the case of proposed projects, to those which were generally recognized as sound and could be undertaken in time to be a factor in the unemployment relief program.

Information collected in this manner, supplemented by data taken from the files of The F. W. Dodge Corporation, and other similar sources, was placed on cards, care being taken to avoid duplication. To date, about 8,000 questionnaires have been received, the greater part of which refer to public works projects other than Federal. As to Federal projects, the section exerted its best efforts to expedite them, drafting remedial legislation to remove legal causes of delay and urging a wider use of private architectural firms in the designing and planning of Federal buildings.

Projects other than Federal fell logically into two classes, first, those proposed, and second, those authorized. In the case of projects lacking authorization, a letter was sent to the local chamber of commerce, to a local employment committee, or directly to the responsible official, depending on circumstances. In this letter, attention was called to the economic wisdom of embarking on public construction projects when building materials were cheap and labor plentiful, and also to the great value of such construction in relieving unemployment distress.

WORK OF EXPEDITING PROJECTS

Field agencies were warned not to advocate for adoption any project unless it was generally recognized locally as economically sound. This was important, as certain selfish individuals sought to take advantage of the situation by seeking the aid of the Public Works Section in the furtherance of projects that would benefit themselves, but not necessarily the public.

In the case of projects authorized, but not ready for construction, the section urged that the preparatory work be expedited, expressing the belief that if all projects in this category could be advanced a month, or even a week, the effect in the aggregate would be an important factor in the unemployment relief program. Where the project was architectural in character, the appeal was addressed to the architect in charge by the representative in the section of the American Institute of Architects; where the project was of an engineering character, the appeal was made by the representative of the American Engineering Council to the engineer

of the project; where projects were delayed due to controversies among agencies that were jointly responsible for their execution, such as controversies between city and county, and city and railroad, an effort was made to expedite a settlement without taking sides.

Letters received by the section indicate that many projects were adopted or hastened as a means of unemployment relief, but how much of the success was due to the work of the committee and how much to the work of local agencies imbued with the same idea, will never be known.

HANDICAPS ENCOUNTERED

As the work of the section is now drawing to a close, it seems opportune to consider whether better results might not have been secured by a less highly centralized organization. The Public Works Section undertook to deal with individual construction projects all over the country, many of them at long range, when it had but meager information concerning them and but little knowledge of local conditions. It had hoped to overcome that handicap by creating certain field agencies that would be in a position to advise as to the economic soundness of proposed projects and to assist in urging their adoption; and by creating certain other field agencies that could best advise as to the causes of delay, in the case of authorized projects, and the best means of overcoming them.

The local chambers of commerce were prompt in furnishing requested information, but few showed any willingness to act as community leaders and to openly urge the adoption of public construction projects in the interest of unemployment relief. As a result, when it seemed wise to urge the adoption of a given project, it soon became the practice of the section to send the appeal, not to one of its field agencies, but to a local unemployment committee, or direct to the officials having the project in charge.

The cooperation received from the local agencies of the American Engineering Council was, in general, disappointing. A small number of them functioned in a highly efficient manner, but many failed to answer or even acknowledge letters of inquiry concerning specific projects. Three reasons for this attitude have been suggested:

1. Officers of Local Sections of the American Society of Civil Engineers are elected, as a rule, for the calendar year, so that the initial request for cooperation and assistance, which was dated December 1, 1930, went to an individual who was going out of office within a few weeks after its receipt.
2. Local Sections of the Society are not organized for work of this character, as most of the secretarial work is voluntary.
3. Local Sections were already cooperating as groups or through individual members with local unemployment committees in expediting public construction, and for this reason looked on the activities of the Public Works Section in Washington as an unnecessary duplication of effort.

A BETTER SYSTEM

These facts are made of record, not in any spirit of criticism of the Public Works Section or of its field agencies, but to support a belief that better results, with less duplication of effort, would have been secured from a modified organization briefly outlined as follows.

Instead of attempting to deal with individual projects other than Federal, let the national public works group confine its activities to building up public works sections of state employment committees, furnishing them, for the sake of uniformity, with blank questionnaire cards and outlining to them desirable forms of organization and methods of procedure. In addition to supplying state public works groups with information, it should stimulate their activities through personal appeals made to them by regional directors appointed for that purpose. In this way the burden of the campaign and responsibility for its success would lie with state groups that would have a much more intimate knowledge of what could be accomplished within their states than any national group could possibly have.

In the smaller, thinly populated states, a single public works group in the state capitol would suffice to cover the state, but in the larger and more populous states, it would be desirable to create a public works group in each city of 500,000 or more inhabitants. These municipal groups should be organized by the state group and given definite territorial jurisdiction, so that every county in the state would be covered by either a state or a municipal public works group.

Such an organization would lack the advantage which lies in the power of a direct appeal from the President's committee, which is greater than that from a state committee; but this loss would be more than offset by the decided advantage of placing primary responsibility on the states, and of building up in each state an organization proportionate to its needs and its financial condition.

The National Public Works Section would logically deal with Federal projects and with projects requiring Federal cooperation or approval. But except for handling such projects, its greatest field of usefulness appears to lie in fostering the formation of state public works groups and in stimulating their activities through correspondence, and by frequent visits from nationally appointed regional directors.

C. W. KUTZ, M. Am. Soc. C.E.
Representative of the American Engineering Council

Washington, D.C.
March 19, 1931

Joint Committee on Concrete and Reinforced Concrete

On February 27 and 28, the Joint Committee on Specifications for Concrete met in the rooms of the Western Society of Engineers, in Chicago. This committee, which is made up of five representatives each of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the Portland Cement Association, and the American Concrete Institute, is a reorganization of the committee that made the reports on concrete specifications which were printed in PROCEEDINGS for August 1921 and October 1924.

Since the 1924 report was issued, a number of developments have made certain changes in specifications desirable. Among these advances, the most significant are those in the use of ready-mixed concrete, together with a more widespread understanding of the design of mixtures and increasing attention to field control. In regard to design, an outstanding development which should be covered in future reports of the committee is the tendency toward the greater use of rigid-frame construction. All these developments are to be given consideration by the reorganized committee, which in addition will make a general study of the 1924 report with a view to improving its presentation and widening its scope.

In its report, the committee also proposes to separate parts which are in the nature of specifications from those which pertain to recommended practice. It is planned also to add as an appendix the technical data on which the recommendations of the report were based. The committee is considering the necessity of distinguishing between the requirements for so-called outdoor concrete and concrete in locations not exposed to the effect of weather, such as heated buildings.

Watertightness as an element of durability will be recognized as one of the essentials of concrete for outdoor exposure. The necessity for this has been brought about by the recent development of generally higher strengths in portland cements. Following the practice of designing concrete for a given strength requirement, which has become quite general, it is possible that, with these newer cements, mixtures will result which are too lean for proper durability. Some limitation, therefore, will be placed upon the cement content to avoid this difficulty.

In the field of design of reinforced concrete, the committee proposes to present the recommendations in regard to moment coefficients by putting primary emphasis on the general case of unequal spans, thus reversing the arrangement in the 1924 report, in which the emphasis is placed on a series of equal spans. Moment coefficients will be given only for the case of equal spans, and these will be presented with separate coefficients for live and dead load.

Many members of the Society are included in this committee as reconstructed. The representatives comprising the present personnel are as follows:

American Society of Civil Engineers: W. A. Slater, F. E. Richart, and W. S. Thomson, Members Am. Soc. C.E.; and M. N. Clair, and A. E. Lindau, Associate Members Am. Soc. C.E.

American Railway Engineering Association: M. Hirschthal and J. F. Leonard, Members Am. Soc. C.E.; C. P. Richardson, Assoc. M. Am. Soc. C.E.; and J. B. Hunley and A. R. Ketterson.

The Society has never held a quarterly meeting in this state, nor, in fact, nearer than Atlanta, Ga., where in 1924 the Spring Meeting convened. Present plans are in recognition of the recent rapid development of Florida and Engineering interests there.

American Society for Testing Materials: A. T. Goldbeck and L. S. Moisseiff, Members Am. Soc. C.E.; C. M. Chapman, P. H. Bates, and E. E. Hughes.

American Concrete Institute: S. C. Hollister, J. G. Ahlers, Members Am. Soc. C.E.; B. Moreell, N. M. Stineman, Associate Members Am. Soc. C.E.; and F. H. Jackson.

Portland Cement Association: F. R. McMillan, and D. A. Abrams, Members Am. Soc. C.E.; Ernest Ashton, J. H. Chubb, and H. G. Farmer.

In organizing, the committee elected Professor Slater as its chairman, and Mr. McMillan as secretary.

Miami for 1932 Spring Meeting

Choice of cities for the quarterly meetings of the Society is on recommendation from a regional committee of Society officers in the proper zone. Such a committee convened at the Norfolk Meeting to choose a place for the corresponding 1932 meeting. After full discussion, Miami, Fla., was selected, pending the approval of the Board of Direction. A recommendation as to the exact date was deferred, with the understanding that it is to be early in April 1932.

Columbia University Scholarship Announced

Through the courtesy of Columbia University, New York, the American Society of Civil Engineers has at its disposal a scholarship in Civil Engineering covering tuition fees, a dormitory room, and $100 allowance for books and similar items (total value, about $700). This scholarship has been established in honor of Horatio Allen, of the Class of 1823, Columbia, and Fifth President of the American Society of Civil Engineers. The scholarship will be awarded by the Scholarship Committee of the Society to a candidate whose records must be approved by the university authorities. It may be held by the successful candidate for from one to three years, depending on the class which he enters at the university.

The engineering course at Columbia consists of a basic four-year course leading to the B.S. degree. Approved candidates may elect a fifth, or professional, year on completion of which they receive the C.E. degree. The first two years of the Columbia engineering course are under the administration of Columbia College, and include mathematics through calculus, descriptive geometry and drafting, general chemistry, physics, English, modern history, and economics. Students applying for the scholarship must submit credits covering at least these first two years. Those who enter at this point will thus require two years to attain the B.S. degree in engineering and an additional year (total three years) for the C.E. degree.

Those who have carried their studies beyond this point will also be admitted. They will be granted advance standing and will continue in the Columbia course for which their previous training fits them. The time required for the B.S. or C.E. degree under these conditions will vary accordingly. It will take a student who has already received a B.S. in engineering at least one, and generally one and one-half years, to meet the requirements for the C.E. degree. For details as to courses and requirements, address the Dean of the Engineering Schools, Columbia University, New York.

Applicants for this scholarship must submit a photograph together with their scholastic record and a letter of recommendation from the dean of their school. Their records must be approved both by the Scholarship Committee of the American Society of Civil Engineers and by the Dean of the Engineering Schools, Columbia University.

Notice is hereby given that the Columbia University Scholarship is now open. Applications will be received by the Scholarship Committee at Society Headquarters until June 1, when an appointment will be made, to begin with the next academic year, which opens September 23, 1931.

Freeman Traveling Scholarship for 1931

Conditions under which the Freeman Traveling Scholarship is to be awarded for 1931–1932 are here announced by the Committee on the Freeman Fund. The purpose in recommending the award of funds for this scholarship is to promote in this country a greater interest in the work of European hydraulic laboratories and to make engineers in America more familiar with continental methods in the design and construction of hydraulic works. The award will be made to the candidate who seems best equipped to learn European hydraulic practice and to disseminate such knowledge in this country.

To be eligible for this scholarship, a candidate must be an American citizen, not less than 24 nor more than 36 years of age, and a graduate of a technical school of recognized standing. It is desirable that he hold membership in the Society.

A candidate must be familiar with the mathematical treatment of hydraulic problems and well grounded in general mathematics. Preferably, he shall have had experience in hydraulic design and construction. A good grounding in the German language is considered essential and preference will be given to those candidates who can speak it.

The sum of $1,600 has been made available for this scholarship, $500 to be paid to the successful candidate on July 1, and $100 on the first of each month for 11 months thereafter. The winner of the scholarship shall bear other expenses, if any. He should leave this country to take up his studies in Europe as soon after July 1, as practicable and should at once begin his work at one of the European technical schools. The studies should be largely in Germany. Not one but many of the hydraulic laboratories, as well as important hydraulic works in Europe are to be inspected.

Brief progress reports from the holder of the scholarship, addressed to the Secretary of the Society, are expected each month for the information of the committee. At the conclusion of the year, he should submit to the Society, in form suitable for publication, a monograph on current hydraulic practice as covered by his studies.

In a letter addressed to the Secretary of the Society, the applicant should set forth his qualifications (age, place of birth, education, experience, references, and photograph), together with not less than six letters of reference from his former teachers and employers. If practicable, he may be requested to come to New York for an interview by the committee. A statement of the field of engineering in which he proposes to work is also requested. The last day for filing an application will be June 1, and the award will be made by the Committee on the Freeman Fund on or before June 15.

Tacoma Entertains Summer Meeting

Again, in the round of Society meetings, it becomes the good fortune of the Pacific Northwest to entertain the Society. The coming Summer Meeting is scheduled for July 8 to 10, to be held at Tacoma, Wash. This is the first quarterly gathering in this territory since 1926, when Seattle opened its doors in a memorable meeting. The present visit to Tacoma is by way of a compliment to one of the youngest of Society Sections. All those who know this territory and the loyal membership who were responsible for the invitation, gladly admit that the coming meeting bids fair to uphold all the traditions of engineering hospitality in the Far West.

As far as technical sessions are concerned, a varied program is in prospect. This meeting, the Sixty-First Annual Convention, will be called to order Wednesday, July 8, and will be distinguished by the presidential address. Other engineering topics and lectures of special interest will deal with the technical advances in the Pacific Northwest.

Many of the Technical Divisions are planning to hold meetings. For example, individual sessions are scheduled for the Irrigation and Structural Divisions on Thursday, while joint meetings will be sponsored by the Power and Construction Divisions, as well as by the City Planning and Highway Divisions. The usual round of special social events will delightfully fill the remaining hours for every member in attendance.

Among the featured excursions will be a special trip on Puget Sound, one of the loveliest as well as most important inland bays in

the world. Municipal and industrial plants will also receive their share of attention. Close at hand, the world-famous Rainier National Park will attract every visitor. There the delightful blending of summer and winter and the magnificent scenery will be found to amply justify the reputation which has been gained by this most popular national park.

Near, too, are the other important cities on Puget Sound, including Seattle, which many members will doubtless wish to visit to enjoy a region full of engineering and scenic interest. Whether the member travels across the continent or along the coast, there are numerous national parks and regions of especial attractiveness which will entice him. As the occasion of an extended summer trip into one of the most beautiful sections of the country, the Tacoma Meeting is expected to draw a large attendance. Official programs, giving all the technical and other details of the meeting, will be issued in ample time for each member to make his plans to visit Tacoma.

Memoirs—Why and How

Reverence for the dead is one of the oldest and most fundamental of human attributes. It is not confined to recent or even to civilized times. Some of the most awe-inspiring monuments of all time, some of the most beautiful edifices created by man are memorials to those who have been considered great by their own or succeeding generations. It is not strange then that a body of educated and professional men should show the greatest respect to those of their number who have passed away. In the Society this takes the form of memoirs.

Some members question the policy and deplore the expense. Why should so much effort be expended to perpetuate details in the history of men whose lives are already merely a memory? To this materialistic view, officers of the Society have continually turned a deaf ear. All our members are eminent men and their prominence does not cease with their death. Without respect for the deceased there cannot be respect for those who soon will be deceased. No organization which does not honor its membership is worthy of existing, to say nothing of growing.

Such has been the attitude of those responsible for Society publication policies. This feeling has increased rather than decreased in recent years, with the result that greater efforts are being made today to obtain memoirs than a generation ago. These efforts show themselves in the increased success of obtaining suitable histories.

Considering that the writing of memoirs is a gratuitous service on the part of friends, it is a striking fact that relatively few members die without the Society being able to obtain a record for publication. Examination of these records shows that only from 5 to 10 per cent of members thus fail to receive recognition.

In only about twenty instances in all its history has the Society been unable to find out just when one of its members died. Information is received in a variety of ways. It may be taken from a newspaper report or, more often, a friend or relative writes. Local Sections are unusually alert to keep Society statistics accurate. Again, returned mail sometimes gives a hint. Of course, the receipt of bills by the family of the deceased, or of cards for registering in the *Year Book* is a reminder that the necessary information should be forwarded.

Whatever the source of information, the first action is an acknowledgment, together with a letter of sympathy to the family. At the same time, inquiry is frequently made as to the suitable persons to approach for obtaining a memoir. Ordinarily, this is best handled through a Local Section. If the member is very prominent, a committee may even be appointed. For an officer of the Society, the Board of Direction often appoints a committee for this purpose.

Most frequently, however, one or more associates of the deceased, particularly those who are familiar with his non-professional activities as well as his engineering experience, are suggested. A formal letter is then written, asking such a person (usually a member of the Society) to undertake the duty of writing a memoir. With this letter is sent all the data on file at Headquarters, including the record abstracted from the application, a copy of the biographical data sheet, items from *Who's Who*, newspaper clippings—in fact, any information bearing on his activities. In addition, a few samples of memoirs previously published are submitted as examples.

Not always is it as easy as this, however. Occasionally, delays or procrastination interfere. Frequently, too, modesty causes the declining of the invitation, especially where the member has enjoyed an unusual prominence. In one recent case a memoir was obtained only after an extensive correspondence covering more than a year between New York and the Philippine Islands and China. Occasionally, a memoir appears under anonymous authorship. As a last resort, it may even be written by the editorial staff, and submitted to the family of the deceased for approval.

With the passing of years, it becomes increasingly difficult to make the necessary contacts and secure suitable memoirs. Most of those members for whom memoirs are lacking are included in two classes; either their death occurred so long ago that it is impossible at this late date to secure authentic information; or they died so recently that their memoirs have not yet been printed.

Deaths of members and the number of memoirs printed are increasing yearly. This is a normal development, consequent to the growth of the Society. At the moment, there are expected to be about 130 memoirs available for printing this year. Assuming that two to three members are active in obtaining each memoir, it is evident that a relatively large part of the membership contributes materially in time and effort to this good work. The aggregate of effort in correspondence, editing, proof-reading, and printing adds to the impressiveness of this activity in relation to other publication work.

Is it all worth the trouble? No one who has looked over Society correspondence for even a few days will doubt it. Perhaps no other one activity of the Society comes closer to the non-technical public. The free distribution of a few copies of each memoir to the deceased family never fails to bring letters of gratitude, some of them appreciative to an unexpected degree. This is an additional proof of service—service to the memory of a worthy man, to his surviving family and professional friends, and lastly, to the ideals of a great profession.

Engineering Employment in Russia

SOCIETY COMMITTEE REPORTS AFTER INTENSIVE STUDY

Board of Direction
American Society of Civil Engineers

Gentlemen:

At the recent Annual Meeting there was suggested to the Society the formation of a committee to study conditions surrounding the employment of American engineers in Russia.

Your committee, appointed in accordance therewith, has given the matter careful study, informing itself by correspondence and by personal interviews with engineers, both Russian and American, who have worked in the U.S.S.R., and submits the following report:

American Engineers in Russia

The Committee desires, at the outset, to stress the fact that the vastness of the subject matter, i. e., conditions in the U.S.S.R. as affecting American engineers, and the conflicting reports thereon, completely precludes definite, unqualified statements on a number of the major features of life and conditions in Russia.

In the opinion of the Committee it is most important that any engineer considering employment in the U.S.S.R. inform himself in every possible way of the conditions there existing. These conditions may and do vary from year to year, or even in a shorter period.

Articles on Russia

The Committee must assume that any engineer considering employment in Russia has at least some information in respect to Russian conditions, in view of the great number of articles which have appeared in the American press and magazines during the past few years. The 24 articles appearing during November and December of 1930, in *The New York Evening Post* by H. R. Knickerbocker, special European correspondent for that journal, entitled "The Red Trade Menace" are considered, perhaps, to be the most accurate picture of conditions obtaining during the second half of 1930 under the Five-Year Plan. The articles prepared by Walter Duranty, special correspondent of *The New York Times*, are of great value as informative of present-day conditions and

trends. Other articles have recently appeared in *The Saturday Evening Post*, written by various engineers who have worked in Russia. A number of Russian engineers who formerly worked in the U.S.S.R., now residing in the United States, have written articles and given addresses descriptive of conditions encountered in Russia. Many, in fact most, of these articles and addresses have been highly unfavorable to the present régimé in power, its goal, and methods employed to attain that goal, which is alleged to be world revolution and communism.

General Conditions

The employment of engineers in the development of the resources of foreign countries is not unusual. The railways and industries of the United States were aided in their early days by money, material, and technical skill furnished by the more advanced countries of Europe. In turn, American engineers and capital have assisted in the development of the countries to the south of us and, to a less extent, of Africa and Asia. Today American engineers are employed by the governments of Persia and China, neighboring countries to Russia, and no one questions the advisability of their being there. Heretofore American engineers have gone wherever their individual desire prompted them. Should Russia be placed in a different category from other nations?

There are two reasons why employment of American engineers in Russia is on a different basis. In the first place, although the present government in Russia has been in power for 13 years, the United States Government has not given it recognition. While it is not the function of this Committee to commend or criticize this policy, it is a fact that must be called to the attention of engineers contemplating work in Russia. They must understand that in case of controversy with the Soviet Government, they cannot call for assistance from any representative of their government, for there is none. Therefore, in this respect American engineers take a risk—whatever it may be—which they do not take in any other country, and which is not taken by British, French, or German engineers.

In the second place, the form of government in Russia is different from that in any other country. Russia is the only country that owns and operates all procedures of production and marketing, for the Soviet Government believes that, in this way, the average well-being of the Russian people will be more rapidly advanced than it is in countries where production and marketing are controlled by private capital. In order to bring about this desired condition in the shortest time possible, the Soviet Government is depriving its people of all luxuries and many necessities. This is done so that the products of the country—mineral and agricultural—can be sold in foreign countries to pay for raw materials, machinery, and technical skill which are essential for the industrialization of the country, wherein lies its future prosperity, according to the theory of the government. Owing to the scarcity of gold and credit, the Soviet Government is compelled to pay largely in goods for what it buys. That is why so much is heard about the dumping of Russian wheat, pulpwood, manganese, etc., for it is only by raising cash in this way that the government can meet its commitments. Thus, while Russian wheat, eggs, and other products are sold freely in neighboring countries, they are rationed in Russia, where the people can purchase only the bare necessities of life.

Service Contract

The Amtorg Trading Corporation, an entity which handles virtually all Russian business in the United States, employs engineers for service in the U.S.S.R. The Committee has examined the form of service contract which is offered to American engineers for employment with the Soviet Government. Although, as in the case of most contracts, certain improvements could be made for the benefit of the employee, the Committee does not feel called upon to express any comment or criticism other than to point out that the form of contract is not dissimilar to that offered by American corporations to American engineers for foreign service. If the policy of the Soviet Government is to treat American engineers with consideration and fairness, there is ample warrant contained in the service contract for such treatment. If, on the other hand, unfairness and lack of consideration develop, as may readily occur in isolated cases, the Committee knows of no way, under present circumstances, by which the Soviet Government may be constrained to change or correct such policy or attitude.

Food Conditions

As the tempo of the Five-Year Plan has increased, living and food conditions have become measurably more difficult for the Russians of all classes and for foreigners in a somewhat lesser degree. These conditions vary so greatly in different parts of the country that any attempt to give an accurate description would be futile and without value, as a period of six months might show the reverse of the picture presented for any one region or locality.

Generally speaking, it may be said that in the greater part of the U.S.S.R. and even in the great cities of Moscow, Leningrad, and Odessa, food is scarce and expensive. No foodstuffs or wearing apparel are imported into the U.S.S.R. except by the diplomatic corps and a few others to whom special privilege has been granted. The vast mass of tens of millions of Russians are living, and have been living for years, on a severely plain, meager, although nutritious diet, but with which few Americans would be content. During the past year the Soviet Government has opened up a number of provision stores for foreigners working in the U.S.S.R. The card system is employed, and these stores have been helpful in many ways to Americans and their families. Although notable progress has been made in the last two years in the way of increased production of cereals, it is difficult to envisage improved food conditions for some time.

Housing

An acute housing shortage exists in the principal centers of population, notably Moscow, the capital, which today has a population double that obtaining before the European War. The government is doing what it can to alleviate this situation in the way of numerous new buildings and great apartment houses. Hotels are expensive in all the principal cities and inadequately heated during winter months.

Money

American money is exchanged into the Russian ruble at the rate of two rubles for one dollar. The purchasing power of the ruble throughout Russia as compared to its dollar equivalent in the United States probably falls within the range of 12 to 16 cents. It is illegal to carry the ruble into the U.S.S.R., and frequently those entering are subjected to search. Foreign currency is exchanged into Russian money at the frontier railroad station (Negersole).

Clothes

Wearing apparel of all kinds is scarce and expensive throughout Russia. The engineer going there should take everything in this line that he is likely to require for at least two years.

Medical and Hospital Facilities

Medical and hospital services, as known in the United States, do not exist in the U.S.S.R. except in the principal cities, although improvement is being made in this respect.

Environment

The American engineer taking up employment in Russia must be prepared to undergo certain hardships and lack of many of the ordinary comforts during the long, severe winter. He must be prepared for lack of diversions, and only in rare instances is it advisable to take his wife and children. He must be prepared to meet and work with native engineers and others whose mentality and viewpoint he will only remotely comprehend. He is certain to be discouraged by what he will consider lack of cooperation and the spirit of getting things done. Few engineers except those possessing in a high degree the pioneer spirit of working under hardships in a strange country and with a foreign people, or those possessed of a spirit of adventure, will be content or able to give efficient service under these conditions.

Diplomatic Relations

As already pointed out, the Government of the United States has no diplomatic relations with the U.S.S.R. although British, German, and French Ambassadors reside in Moscow. There is therefore no American embassy, nor are there American consuls, in the U.S.S.R. This condition further accentuates the difficulties surrounding Americans in Russia, as in case of serious trouble with the Russian Government or any of its officials, there is no United States diplomatic or consular representative to whom

appeal can be made for assistance or intervention. In this respect, therefore, American nationals are at a disadvantage as compared to those of Germany, France, and England.

Although there can be no question but that severe and, no doubt, unfair treatment has been the lot of many Russian engineers and technicians under the present régimé, the Committee knows of no cases of drastic ill treatment or unfairness toward American engineers in the U.S.S.R. The policy of the Russian Government in recent years has been one of rapprochement toward the American Government, with official recognition as its ultimate goal. In the development of this policy, the Russian Government has placed large orders in the United States for construction and agricultural machinery, electrical equipment, and the like. A further and no less important phase of this policy has been the employment of hundreds of American engineers, mechanics, and technicians, as well as several American engineering firms for special work.

Treatment of American Engineers

During the years 1928, 1929, at which time a large number of American engineers accepted employment in the U.S.S.R., it is certain that these engineers, as well as the hundreds of American mechanics also engaged, were treated with marked consideration and were actually in a preferential position to that of other foreigners working in the country. This situation brought forth protests from other nationalities working in the U.S.S.R. During the same period the Russian Government entered into contracts with several American engineering and construction organizations for the carrying out of such work as the design and construction of grain elevators, cement and steel mills, hydro-electric work, and paving and road construction.

The Committee is informed from various reliable sources that in recent months a perceptible change has occurred in this respect and that friction has developed in numerous instances between American and Russian engineers. The Committee believes that only the most elementary knowledge of working conditions in foreign countries is required to a realization that such a situation, i. e., friction and misunderstanding between engineers of different nationalities, is easy, in fact almost bound to occur. The lack of a common language—utterly unattuned and unsynchronized mentalities and viewpoints—the severe strain placed upon engineers, national and foreign, working under the present rapid tempo of the Five-Year Plan—the natural and understandable antipathy or even hostility on the part of the Russian engineer toward foreign engineers enjoying higher salaries and better living conditions—are all contributing factors toward creating a situation of envy, friction, and misunderstanding.

The lack of cooperation on the part of Russian engineers toward their foreign colleagues has also been stressed by many recently returning from Russia. This again is easily understandable and not surprising. Under the system prevailing in the U.S.S.R., serious errors, either in design or execution, on the part of native engineers are severely punished; in fact, the death penalty has been frequently imposed. Under these conditions it is not strange that the Russian engineer is actually fearful of direct responsibility and may be primarily interested in establishing an alibi for himself in case of trouble. This situation has led inexorably to confusion and chaos in the preliminary work of several large construction projects.

Notwithstanding conflicting reports emanating from both the U.S.S.R. and this country on the subject of the precise position of American engineers in Russia, it seems certain that neither American engineers nor American engineering firms occupy the preferential position enjoyed one and two years past. In the early stages of the Five-Year Plan, the Russians eagerly sought foreign technical assistance and collaboration. As the success or partial success of the Five-Year Plan took concrete form in the minds of the Soviet chiefs and their lieutenants, there developed a marked tendency to assume an ultra-independent attitude toward foreigners both in and out of the U.S.S.R. This sentiment was, no doubt, also in part fomented by the presence in Russia of incompetent foreign engineers and technicians, or those whose usefulness was seriously impaired by discontent and inability to adjust themselves to existing conditions.

Conclusion

The Committee believes that, up to this time, there has been no ground for real or serious complaint on the part of those employed. The Committee believes, however, that no prediction is possible as to the length of time nor the degree in which the present attitude of good will toward Americans will continue.

R. W. HEBARD
GEORGE W. KITTREDGE
GEORGE H. PEGRAM
JOHN R. SLATTERY
PHILIP W. HENRY, *Chairman*

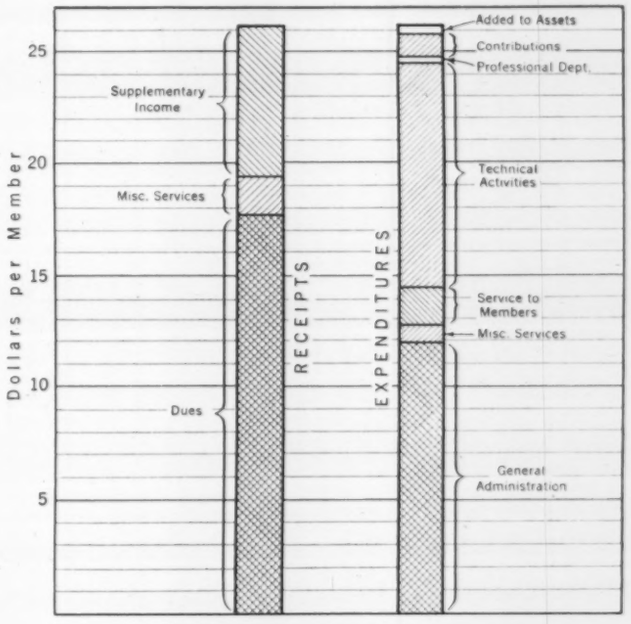
April 10, 1931

(*Additional information may be secured on application to the Headquarters of the Society.*)

Explaining a Financial Mystery

HOW MEMBERS RECEIVE MORE FROM THE SOCIETY THAN THEY CONTRIBUTE

Financial statistics are apt to be misleading. The average citizen, on reading a balance sheet of assets and liabilities, expenditures and receipts, is inclined to feel that it may disguise almost any condition of success or even of insolvency.



UTILIZING MEMBERSHIP DUES
Society Receipts and Expenditures for 1930

What the annual financial statistics of the Society disclose to an inquiring student may be illustrated by the attached chart and a brief description of its origin. All the data are taken from the 1930 Report of the Secretary to the Board of Direction (printed in PROCEEDINGS for March), giving in detail the sources and destinations of current income and other useful statistics of a financial character.

Many items are included in the income, classified under various headings. First come the "Dues." No member needs further enlightenment on this heading. The next item contributing to the receipts in any year may be gathered under a general heading of "Miscellaneous Services." In this would be included sales to members of certificates, badges, the binding of TRANSACTIONS, Annual Meeting tickets, and other miscellaneous items.

Finally, on the same side of the ledger, is another major item of "Supplementary Income," including such things as entrance fees, rent, advertising, contributions, and sale of publications. Comparing these on a percentage basis, it is found that the component parts are related as follows:

Dues	67.6
Miscellaneous Services	5.9
Supplementary Income	26.5
Total	100.0

On the opposite side of the ledger is a corresponding series of subjects, the first being "General Society Administration," including such matters as salaries, travel of officers, interest on mortgage, office expenditures, general publications, and general postage. Next on the list comes "Miscellaneous Service Administration," which corresponds roughly to the income received for the same purpose and therefore includes such items as the purchase of certificates, badges, and bindings.

Coming to the more specific subdivisions, there is found one on "General Service to Members." This comprises contributions to administrative committees, Local Sections, the Engineering Societies Library, the Employment Service, the Reading Room, and annual prizes. Another large subdivision covers "Technical Activities." Included here are payments to Technical Divisions and technical committees, expenses of meetings, and the cost of technical publications.

Under still another heading, "Contributions," may be found such matters as support of the American Standards Association, the Engineering Summer School, and the American Engineering Council. In addition to the foregoing general items, two other main groupings, although relatively small, do not lend themselves easily to other classification. These include "Professional Activities," and the capital "Added to the Assets of the Society." On a percentage basis, these items of outlay are found to be as follows:

General Society Administration	45.7
Miscellaneous Service Administration	3.0
General Service to Members	6.5
Technical Activities	38.5
Professional Activities	0.6
Contributions	4.5
Additions to Assets	1.2
Total	100.0

In considering the distribution of these many items, it may help to refer to them as in the chart, in terms of dollar values to each member—on the one hand the receipts, and on the other, the expenditures. This gives visually the answer to the financial mystery. On one side is an average receipt for dues of about $17.75, while on the other there is an expenditure to each member of over $26.00 yearly. These are the figures for 1930. Corresponding figures for the 1931 budget are even more striking, the expected average income from dues being $17.30 per member and the proposed expenditures, $29.00 per member.

The difference, or the key to the problem, is found in the supplementary income, in part current payment for specific objects by members, it is true, but largely the returns from investments of a sound character made in years gone by. It may be noted that this policy, which is now paying dividends to each member, is still in force and that part of the expenditures each year are in the form of a capital investment which will yield increasing returns in the years to come.

New Rail Sections for Pennsylvania Railroad

An announcement of unusual interest to engineers was incorporated in the paper prepared by Elisha Lee, Vice-President Pennsylvania Railroad, and delivered before the general session at the Norfolk Meeting of the Society by W. S. Franklin. For two years, a committee of engineers of the railroad, in conjunction with representatives of the steel companies, has been investigating the redesign of railroad rails for heavy duty. As a result, early in May, the United States Steel Company and the Bethlehem Steel Company will roll the first heats of the new sections for the Pennsylvania Railroad.

Its weight of 152 lb. to the yard will make the new rail the heaviest and strongest ever rolled for regular service. It will supersede the present standard of 130 lb., and will exceed the current section by $1^3/_8$ in. in height, at the same time yielding approximately 75 per cent greater stiffness. Thus, it fills the need for a section designed to carry increased traffic and increased load, with greater speed and safety than ever before. The committee considered this sufficient in strength to carry a 100,000-lb. axle load at 100 miles per hour, as compared with a maximum of 80,000 lb. at 80 miles per hour under present-day operation.

Comparably, the present 130-lb. section has been redesigned to a weight of approximately 131 lb., but with the addition of 22 per cent to the present stiffness. This lighter section will be standard for main-line tracks except where dense traffic requires the heavier rail. New splice bars are also to be made available to accommodate the new section.

In his interesting paper, Mr. Lee enumerated other advances made by the Pennsylvania Railroad. He cited one development under which the railroad is replacing local freight trains by automobile trucks, which now cover regularly almost 1,800 route miles daily, with large economies. Portable containers are also yielding great savings. These are capable of being carried either on motor trucks through city streets, or on specially equipped flat cars. In this way, a combination of the most economical handling is readily possible.

Still another measure of economy is about to be undertaken in the rail transportation of detachable auto-truck bodies. The railroad will carry the loaded truck bodies between cities, but the local handling to and from railroad terminals will be done entirely by the power unit which picks up the truck bodies. Estimates of the railroad show that transportation between New York and Philadelphia, roughly 100 miles, can be effected at just half the trucker's cost.

This most interesting paper will be abstracted at greater length in the June issue of CIVIL ENGINEERING, together with the other papers from the Norfolk Meeting.

News of Local Sections

CENTRAL ILLINOIS SECTION

A joint meeting with Mu San, a professional municipal and sanitary fraternity, was held by the Section on March 27 at Urbana. The feature of the occasion was an address by Harrison P. Eddy, a former Director of the Society, who gave a résumé of the history of the Society and outlined its future work. The Section voted to help the Student Chapter send delegates to the Norfolk Meeting by authorized vote and the gift of $100 for expense money.

CENTRAL OHIO SECTION

Columbus was the scene of the regular monthly meeting of the Section held on March 19. Entertainment was provided by demonstration of the working of a new motion picture camera projector. Three films, "Building New York's Newest Subway," "Magic Yellowstone," and "Arc Welding in the Upper Carnegie Building," were shown. Following this program, the secretary was authorized to purchase the moving picture camera and projector recommended by the committee that has had the matter under advisement.

CLEVELAND SECTION

An address by F. E. Schmitt, Editor of the *Engineering News-Record*, was the principal event of a luncheon meeting held by the Section on March 4. The subject chosen by Mr. Schmitt was the status and future of the engineering profession. The meeting was attended by 33 members and their guests.

At the luncheon meeting held on April 7, various business details were attended to. Among these was the appointment of a committee to investigate the matter of the segregation of the Water Resources Branch of the U.S. Geological Survey as an independent bureau. An interesting talk regarding unemployment conditions was given by B. C. Seiple, Superintendent of the State-City Employment Service.

COLORADO SECTION

A meeting of the Colorado Section was held at Denver, February 24, with 26 members and guests in attendance. The speaker for the occasion was Prof. E. Grosvenor Plowman, of the Bureau of Business and Social Research, University of Denver, who chose for his subject, "Economic Depressions—Their Causes and Possible Solution."

CONNECTICUT SECTION

A dinner meeting of the Section was held at New Haven on March 6. The Section had as its guests President Stuart and

Secretary Seabury. President Stuart addressed the meeting on the subject of "Engineers," while Secretary Seabury gave an account of the work of the Society.

DULUTH SECTION

The Duluth Section, at its regular meeting on February 16, heard a talk given by A. P. Cook, Secretary of the St. Louis County Poor Commission, Duluth, on the subject of relieving the poor and unemployed with money supplied by public taxation. On March 16, the meeting was devoted to a discussion of the Duluth Central Heating System, a public utility now in formation for the purpose of supplying steam for general heating in the business section of the city. There were 19 members and 4 guests present.

GEORGIA SECTION

There were 27 members and guests in attendance at the regular monthly meeting of the Section held in Atlanta, March 2. The speaker of the occasion was J. W. Wingate, President of the Allied Safety Council of Georgia, who discussed the promotion of the safety idea among the construction forces of the Georgia Power Company.

A joint meeting of the Georgia Section and the Georgia School of Technology Student Chapter was held April 2 at the Georgia School of Technology. Several interesting addresses were given. Among those who spoke were H. J. Stemm, who discussed tests and experiences with steel beams encased in concrete, and various calculation methods, and H. D. Warner, who outlined the methods followed by the two in their researches on structural members at the School of Technology.

LOS ANGELES SECTION

The regular monthly meeting of the Los Angeles Section was held March 11, with 164 in attendance. An illustrated talk on the Mono Basin development was given by E. A. Bayley and W. H. Hurlburt. This was followed by an illustrated address on Los Angeles viaducts, given by Merrill Butler.

A meeting of the Sanitary Group of the Section took place March 25. The speakers of the evening were W. H. Adams, of the Los Angeles County Surveyor's Office; P. H. Deming, President of the Deming Corporation; and P. Diederich, Water Works Superintendent of Glendale, Calif.

At the meeting of the Section held on April 8, Ray F. Goudey, Sanitary Engineer of the Los Angeles City Department of Water and Power, gave an illustrated talk on sewage plants in general and reclamation plants in particular, explaining in detail the experimental plant that he is operating for the city. The other speaker for the occasion was Chester A. Smith, of the firm of Burns, McDonnell, and Smith, who presented an illustrated paper on water purification.

NEW MEXICO SECTION

Albuquerque was the scene of the regular monthly meeting of the Section held February 18. The principal speaker was Joseph L. Burkholder, Chief Engineer of the Middle Rio Grande Conservancy District, who gave an informative discussion on the Colorado River Aqueduct Project for Southern California. Short talks were also given by two guests, Maj. William S. Post, Director of Irrigation for the U.S. Indian Service, and H. J. Hagerman, Special Indian Commissioner for the Southwest.

NEW YORK SECTION

The meeting of the New York Section on April 15 was addressed by George W. Fuller, Consulting Engineer of New York, who described in detail the new Ward's Island Sewage Treatment Plant now under construction. It is estimated that the plant will handle an average daily flow of 180,000,000 gal. of sewage, serving a population of 1,350,000 people. The sewage will be conveyed to Ward's Island by two tunnels—one from Manhattan and one from the Bronx. The plant is of the activated sludge type. It is planned to dump the sludge at sea from specially built barges. Because of the rather conspicuous location of the plant, near the Hell Gate Bridge and the New York Connecting Railroad, the architectural treatment will be an important feature.

In its campaign for new members, the New York Section has now reached a membership of nearly 1,200. The Section is considering amendments to make its work more effective and the advisability of a change of name to something more appropriate for a membership that includes sections of Connecticut and New Jersey.

NORTH CAROLINA SECTION

Various interesting features marked the annual meeting of the North Carolina Section, held at the Manufacturers' Club in Charlotte, April 20. In addition to introductory addresses given by President Stuart and Secretary Seabury, various other discussions were presented. Among those who spoke were L. W. Wallace, Executive Secretary of the American Engineering Council; W. S. Lee, Vice-President and Chief Engineer, Duke Power Company; R. E. Wheeler, Major, Corps of Engineers, U.S.A.; and J. E. S. Thorpe, President, Nantahala Power Company. Election of officers for the current year resulted as follows: W. S. Fallis, President; W. C. Olsen, Vice-President; Thorndike Saville, Secretary.

PANAMA SECTION

The newly organized Panama Section held its inaugural meeting at Panama on February 27. Among those in attendance were Past-President Marston and a number of his colleagues on the Inter-oceanic Canal Board.

PHILADELPHIA SECTION

Water supply and sewage treatment, with special reference to Philadelphia and the Delaware River, was the subject chosen for discussion at a meeting of the Section held March 20. There were 60 members in attendance at the dinner, and 112 at the meeting that followed. The speakers included Abel Wolman, Chief Engineer of the Maryland Department of Health, who described the present trend of the art of water and sewage purification; Harry M. Freeburn, District Engineer, Pennsylvania Department of Health, who spoke on Delaware County's five-million-dollar sewage treatment project; and John Meigs, Consulting Engineer of Philadelphia, who outlined the Tri-State Water Case now pending before the U.S. Supreme Court.

PORTO RICO SECTION

The Section held its quarterly meeting on March 21. Besides the usual business routine, technical papers were read by various members. On March 23, President Hoover landed at Ponce Harbor. Since he is an Honorary Member of the Society, a committee from the Section was appointed to extend the Society's cordial greetings to him.

ST. LOUIS SECTION

There were 30 in attendance at the monthly luncheon meeting of the Section, held March 23. The members were addressed by Maj. Roy F. Britton, President of the Automobile Club of Missouri, and a former member of the State Highway Commission, who pointed out the vast improvement made in design and construction of state highways during the last decade.

SAN DIEGO SECTION

The regular monthly meeting of the San Diego Section was held on March 26. At the conclusion of the routine business session, Dr. Leonard Smith presented a large number of slides of the earthquake and fire at Tokio and Yokohama in 1923. He spoke on "International Relations."

SYRACUSE SECTION

On February 25, the Section had as its guests Edward P. Lupfer, Director of the Society, and the officers and senior class members of the Syracuse University Student Chapter. After Mr. Lupfer had addressed the meeting, Marshall B. Palmer presented an illustrated lecture on "Construction of the Knapp Reservoir at Syracuse, N.Y."

TACOMA SECTION

At a dinner meeting of the Tacoma Section, held March 9, Prof. Frederick A. McMillin, of the College of Puget Sound, addressed the members on the subject of the glacial drifts of the Puget Sound region. The geology of this terrain is of particular interest to local engineers because of the location of the auxiliary water supply of the City of Tacoma in a system of local wells.

TOLEDO SECTION

The dinner meeting of the Section held February 25 was well attended. The members were addressed by Charles Kyes Allen, Resident Engineer on the Maumee River High Level Suspension Bridge now under construction at Toledo, on "The Cooper River Bridge at Charleston, S.C."

A Preview of Proceedings

In the May issue of PROCEEDINGS will be presented two major papers of widely varying interest, dealing with field methods used to obtain a good quality of concrete, and practical applications to construction of laboratory studies on soil. An extensive study of boundary surveys by a committee of the Surveying and Mapping Division is presented for a general discussion and further study by members of the Society.

MANUFACTURING CONCRETE OF UNIFORM QUALITY

A large fund of information on a variety of subjects is made available for the engineering profession through the completion of nine important locks and dams on the Ohio River between Louisville and its mouth. One field that certainly might be expected to yield new experience is that of the manufacture of concrete, 750,000 cu. yd. of which were poured on this work. From this standpoint the paper on "Manufacturing Concrete of Uniform Quality," by William M. Hall, M. Am. Soc. C.E., should prove particularly valuable to construction engineers.

As stated by Mr. Hall, the purpose of his paper is to record the results obtained and to give a detailed description of the methods pursued in the manufacture of concrete on the Ohio River dams. It is his hope thus to inspire in others an ambition to adopt and perfect the process of manufacturing concrete of a specified strength and grade with a reliability equal to that of the best of other structural materials.

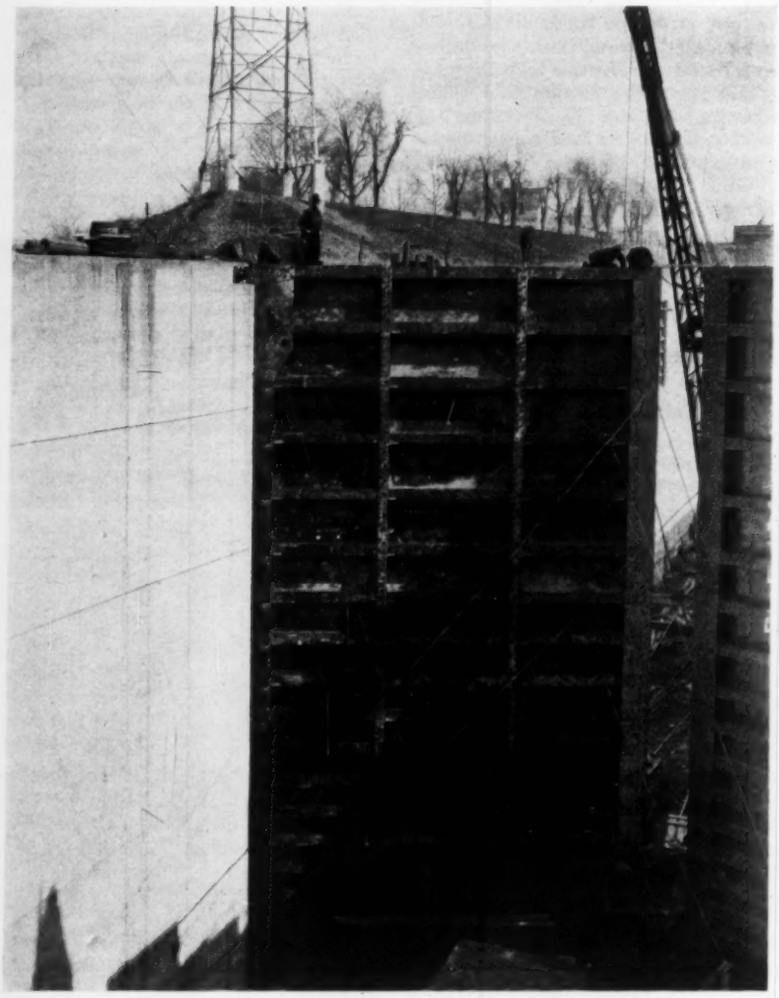
In Appendix I, Clifford F. Little, Inspector on Auxiliary Lock 41, discusses the making and seasoning of concrete test cylinders in the field. He describes some of the important items involving the fair sampling, making, curing, and breaking of cylinders.

The cylinders in the photograph were made in 1929. At the age of six months, Cylinders 53 and 54 were subjected to loads of 200,000 lb. without causing failure. This was the compression limit of the testing machine. One month later, Cylinder 53 broke under a total load of 194,000 lb. and Cylinder 71 under 182,820 lb.

An unusual number of stones sheared through, as demonstrated in the accompanying photograph. The pebbles used as aggregate, from the top surface layer of an Ohio River bar, have a crushing strength much greater than newly quarried limestone, granite, marble, or other stone used for concrete, except possibly the igneous rocks.

In Appendix II, entitled "Standards of Inspection for Concrete Construction," Inspector R. W. MacBeth outlines some details of construction frequently overlooked, misunderstood, or unknown by the operators that are assigned to the operation of mixers. On concrete work, he questions the wisdom of hiring laborers who have inadequate knowledge, and sometimes no experience.

JOB CYLINDERS FROM LOCK 41
Note Broken Aggregate



AUXILIARY LOCK 41, OHIO RIVER
Louisville, Ky.

SPECIFICATIONS FOR BOUNDARY SURVEYS PREPARED

What standards should be observed in making boundary surveys, and what procedure is commonly accepted as the most desirable to be followed? These and similar questions have been extensively studied for a long time by a committee of the Surveying and Mapping Division. Now they are brought into the open in the form of a report in PROCEEDINGS.

This report dwells on the importance of the surveyor's work and discusses the desirable limits of accuracy in surveys of varying importance and size. All the resulting surveys depending one on the other are related according to the degree of precision and the order of importance. In faithfully performing his work, the surveyor must insist not only on accuracy but also on the specific description of his boundary, not yielding to the interest of lawyers or others in the matter of the right of accurate location.

The various points brought out by the committee are being spread on the records of the Society in order that the fullest and freest discussion may ensue. It is hoped that a Manual may then be based on the best concensus of engineering opinion. The work of formulating these specifications has been done under the chairmanship of C. T. Johnston, M. Am. Soc. C.E.

ITEMS OF INTEREST

Engineering Events in Brief

Dues Remitted for Graduating Students

MANY MEMBERS of Society Student Chapters will be graduating from college shortly and their minds perforce turn to the thought of joining a great profession. One of the privileges of their new status is the opportunity of affiliating with the Society.

On its part, the Society has encouraged such affiliation by making the conditions as simple as possible. This applies to the minimizing of necessary credentials, but particularly to a reduction in financial obligation. This latter feature may well be brought to the attention of every graduating student just now.

According to the Society's By-Laws, a member of a Student Chapter who applies for admission within two months after graduation is accorded the remission of the first year's dues. The only other condition is that he should have been in good standing in his Student Chapter for six months continuously preceding graduation. Aside from according financial help at the time when it may be most seriously needed, this plan has the further advantage of providing a continuous affiliation with the Society, which should be a matter of pride to any young engineer.

One of the most convenient ways of taking advantage of these provisions is to fill out the application while still in college and submit it as soon as eligibility by actual graduation is attained. Faculty Sponsors have already been provided with a supply of application forms. They will be glad to assist in simplifying the process as far as possible. The only payment involved is that of an initiation fee, which is not due for several months, that is, when the Board of Direction of the Society has finally passed on the candidate.

Because the passage of time after graduation makes it increasingly hard to comply with the requirements, it is found advisable for students to complete their applications while they have the facilities of their colleges and Student Chapters still at their disposal.

Enlarged Copies of Jarvis' Rainfall Table Available

IN RESPONSE to the urgent request of members, arrangements are being made whereby it is hoped that those who so desire may receive enlarged copies of Table I of observed rainfall for various periods of time, as published by C. S. Jarvis in the January 1930 issue of PROCEEDINGS. This paper has been open for discussion for more than a year and, as a result, some corrections have been made preparatory to its final publication in TRANSACTIONS.

For the benefit of those who anticipate using this table for constant reference, providing there is a sufficient demand, it may be possible to supply complete sets consisting of sheets of 11 by 17-in. paper. This size is selected so that the entire set of 14 sheets may be folded in convenient form for filing or for use in $8\frac{1}{2}$ by 11-in. containers.

The table contains rainfall records for 831 observation stations throughout the world. There are 61 column headings for each observation station, including the mean monthly, the maximum 24-hour, and the total monthly rainfall, for each month in the year.

Those who desire to avail themselves of this tentative offer, at the rate of $2.00 per set of 14 sheets, should drop a card to the Secretary immediately. It is hoped that the number of orders received will justify the effort to perform this added service to members.

Code of Arbitration Practice Published

PUBLICATION OF the *Code of Arbitration Practice and Procedure* of the American Arbitration Tribunal has been announced by the American Arbitration Association. In addition to the two volumes of the code, subscribers to the American Arbitration Service receive a supplementary bulletin information service, which is issued by the Commerce Clearing House of the Corporation Trust Company, the first monthly loose-leaf service on commercial arbitration to be published in any country.

Under a standard practice, which has wide application, the code outlines each step in an arbitration proceeding. It should appeal to individuals and corporations using arbitration or including arbitration clauses in their agreements, and to trade executives or bodies using arbitration in trade activities.

Material for these publications is prepared by the American Arbitration Association, an organization with which members are doubtless already familiar. The service also includes, without additional charge, consultation in person or by letter with the staff of the association. Information will be furnished on arbitration clauses adapted to different forms of contracts, and on any current problem or question submitted. Practice sheets giving details of procedure under different state statutes will be provided, as well as drafts or amendments of rules of procedure. This national system of arbitration is available in 1,700 cities of the United States, including a national panel of 7,000 arbitrators serving without compensation. For installation and current reports, the charge is $15 for one year's service, or $25 for two years. Inquiries should be addressed to the American Arbitration Association, 521 Fifth Avenue, New York.

COMING EVENTS

SUMMER MEETING
AMERICAN SOCIETY OF CIVIL ENGINEERS
In Tacoma, Washington
July 8, 9, 10, 1931

AMERICAN ENGINEERING COUNCIL
Meeting of the Administrative Board, Washington, D.C., May 15,16

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Fifth National Technical Meeting of the Aeronautic Division, Baltimore, May 12–14

AMERICAN WATER WORKS ASSOCIATION
New York Section, annual convention at Pittsburgh, May 25–29
Pacific and Northwest Section, annual meeting in Vancouver, B.C., May 14–16

MARYLAND DELAWARE WATER AND SEWERAGE ASSOCIATION
Annual conference in Wilmington, Del., May 5, 6

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
Spring meeting of the Middle Atlantic Section, Pratt Institute, Brooklyn, N.Y., May 9

Biographies of Living Engineers

BY ALL ODDS, the most ambitious effort thus far made to furnish in published form the biographical histories of professional engineers is represented by the volume known as *Who's Who in Engineering*. The latest issue of this useful publication is dated 1925. So important is this work considered that engineers are cooperating, through the agency of the American Engineering Council, to assist in securing information for the forthcoming issue, which will shortly go to press.

The Society also is lending its assistance, and has cooperated to the extent of sending out letters to a number of members who have, for one reason or another, failed to send in their biographical information. No kind of commercialism attaches to this action and it should not be misinterpreted. The only interest of the Society is in seeing that a publication which has been found reliable and helpful in the past should be encouraged to continue its work.

Only engineers of outstanding and acknowledged professional eminence are to be included. As a measure of such eligibility, an experience of 12 years'

practice, of which 5 years have been in responsible charge of important engineering works, is considered essential. In addition, engineering professors of equivalent experience are considered likewise eligible. It will be seen that these provisions practically coincide with the requirements for the grade of Member of the Society. Every such Member is therefore a candidate for inclusion in *Who's Who in Engineering*. Judged by previous issues, the next volume should include between 15,000 and 20,000 records.

Frequent inquiries are addressed to Headquarters regarding this movement, often with an intimation of doubt as to the propriety of the action requested and of the resultant obligation. The answer is invariably that the publication is reliable, judged by a rather intimate experience covering almost a decade; and further, that no obligation is entailed as to subscription, by sending in the desired information.

If this notice serves to relieve any doubt which may still exist in the minds of members and to promote the widest cooperation in issuing the coming volume, it will have served a useful purpose. Inquiries may be addressed to *Who's Who in Engineering*, 80 East 11th Street, New York, N.Y., and returns are to be made to the same address.

Safety Code for Mechanical Refrigeration

THE AMERICAN STANDARDS ASSOCIATION has just released a manual, *The American Standard Safety Code for Mechanical Refrigeration*. This code, developed under the leadership of the American Society of Refrigerating Engineers, has already been adopted in its entirety by several cities, and other cities are considering its adoption. It represents one of the most important instances of the necessary precautions being taken by industry to prevent improper installation or use of technical equipment without waiting for public demand to force regulation. Copies of the manual may be obtained on application to the American Standards Association, 29 West 39th Street, New York.

Engineering Societies Monographs

THE ENGINEERING SOCIETIES LIBRARY announces the completion of arrangements for the publication of a series of technical treatises to be known as *Engineering Societies Monographs*. Editorial supervision of this series will be in the hands of a committee consisting of Harrison W. Craver, Chairman, Director of the Engineering Societies Library, and two representatives appointed by each of the Founder Societies. They are: Ole Singstad and Charles H. Stevens, American Society of Civil Engineers; Sydney H. Ball and S. Skowronski, American Institute of Mining and Metallurgical Engineers; W. A. Shoudy and S. W. Dudley, American Society of Mechanical Engineers; E. B. Meyer and W. I. Slichter, American Institute of Electrical Engineers.

For many years those who have been interested in the publication of papers, articles, and books devoted to engineering topics have been impressed with the number of important technical manuscripts which have proved either too extensive for publication in periodicals, or of too specialized a character to justify ordinary publication in book form. Heretofore, no adequate funds or other means of publication have been provided in the engineering field for making these works available to the profession.

Engineering Societies Monographs will not be a series in the usual sense of that term. They will be of uniform size, but there will be no regular interval in publication, uniformity in price, or relation in subject. The aim is to make immediately accessible to many users, information which otherwise would be long delayed in reaching more than a few.

The first volume projected for the series is *Plasticity*, by Dr. A. Nadai, formerly with the University of Goettingen, and now associated with the Research Laboratories of the Westinghouse Electric and Manufacturing Company. It is an adapted and revised translation of Dr. Nadai's well known treatise in German on this subject.

Address further inquiries to Harrison W. Craver, Engineering Societies Library, 29 West 39th Street, New York.

NEWS OF ENGINEERS

THOMAS P. PENDLETON has resigned his position with Brock and Weymouth, Inc., and joined the staff of the Aerotopograph Corporation of America, 1800 E Street, N. W., Washington, D.C., as Chief Engineer.

FRANCIS F. GILLEN, who was General Superintendent of the Charles H. Tompkins Company of Washington, D.C., is at present Engineer in the Office of Public Buildings and Parks, in the same city.

ALBERT F. REICHMANN, formerly Division Engineer of the American Bridge Company in Chicago, has recently been advanced to the position of Assistant Chief Engineer. He will still maintain his offices in Chicago.

OTIS E. HOVEY, for a number of years Assistant Chief Engineer of the American Bridge Company, has been made Consulting Engineer for the same company. Mr. Hovey will continue to have his headquarters in New York.

KENDALL K. HOYT has left the McGraw-Hill Publications, for which he was a reporter in Washington, D.C., and is now an Adviser on the President's Emergency Committee for Employment.

JOHN I. PARCEL has accepted a professorship in Structural Engineering at the University of Minnesota. Mr. Parcel has been Construction Engineer in the firm of Sverdrup and Parcel, in St. Louis, Mo.

ARTHUR J. READY, having left the Brown Paper Mill Company of Monroe, La., is now Resident Engineer for George F. Hardy in New York City.

CHARLES S. GLEIM has been appointed Assistant Engineer of Construction with the Port of New York Authority.

GEORGE A. HALKIOPULOS, formerly Construction Engineer for the Petsandis Halkiopulos Company in Athens, Greece, is at present Chief Engineer of the Kadmos Company, Inc., also in Athens.

FREDERICK D. GREGLOW, Industrial and Structural Engineer of Tulsa, Okla., is now connected with the Smith Construction Company of that city as Engineer.

GEORGE S. WEBSTER, Construction Engineer of Philadelphia, has been elected Honorary Vice-President of the Regional Planning Federation of the Philadelphia Tri-State District.

CHARLES S. BILYEU is associated with the Robert W. Hunt Company of Chicago, Ill., as Manager of Structural Materials. He had been with the firm of Sanderson and Porter in New York City.

FRANK RULLAN has left the Union Carbide and Carbon Corporation and is now Structural Designer for Gibbs and Hill Inc., New York City.

WILLIAM C. PARRISH is Instrumentman for the Tennessee Department of Highways.

WILLIAM F. BARCK, who was an associate of Gerald W. Knight, is at present Engineering Consultant for Municipal Engineering, the division of water, roads, and tax maps, in Caldwell, N.J.

MANUEL ALONSO FRIERE has become Steel Designer for Dwight P. Robinson in Montevideo, Uruguay.

JOHN S. BERGER, SR., at one time associated with J. A. Roebling Sons and Company, is now with the W. P. McGarry Company as Field Engineer on the Hudson River Bridge project.

HARRY M. HUY, who was Assistant Engineer for the Public Works Engineering Corporation of New York, has accepted a position with the Trojan Engineering Corporation, in the same capacity.

J. R. MARTINEZ PONTE is one of the civil engineers connected with British Controlled Oilfields, Ltd., in Carracas, Venezuela.

FRANK A. SCHAAK, JR., has left Ash, Howard, Needles, and Tammen, and is now a Project Engineer for Stayton and Veatch, Construction Engineers in Kansas City, Mo.

LEO M. CHARM, formerly Chief Engineer for the Blandine Construction Company, is at present with Maurice Blumenthal, Inc., New York City.

EUGENE J. VAYDA, who was Hydraulic Engineer for the Trojan Engineering Corporation, is now with John Thatcher and Son, Contracting Engineers, Brooklyn, N.Y.

C. MILTON MACWILLIAM has joined the Connecticut Light and Power Company as Office and Field Engineer.

MURRAY L. HUTTON, one-time Superintendent of State Parks in Des Moines, Iowa, is now Engineer and Superintendent of the Board of Iowa Conservation.

FREDERICK W. KOSTING has transferred from the McClintic-Marshall Company to the Construction Department of the Gulf Refining Company, where he is Structural Engineer.

MARCUS A. PORTER has left Parrish and Company to accept a position with A. W. Baker, in Barranguillia, Colombia.

RALPH W. LEWIS is Assistant Engineer for the New England Power Engineering and Service Corporation in Boston, Mass.

HERBERT L. WHITEHEAD, who was with the Ringwood Company, has now become a member of the firm of Eschen and Whitehead of Monsey, N.Y.

MILTON E. TRENAM is connected with the U.S. Bureau of Reclamation, Coalville, Utah, as a Draftsman.

CHARLES S. ISRAEL, who has been a Designer with the United Engineers and Constructors, Philadelphia, Pa., is now with the Guibert Steel Company, Pittsburgh, Pa., as Structural Engineer.

STEPHEN F. PUFF has become Cable Engineer for the Eastern Telephone and Telegraph Company, in Saint John, New Brunswick, Canada.

ABRAHAM VERDUIN is with the Hydro Engineering and Chemical Company of Elizabeth, N.J. He was associated with the Public Service Production Company.

A. A. MCLEAN has been appointed Shire Engineer, with headquarters at Ballan, Victoria, Australia.

OTTO E. ECKERT has accepted the position of General Manager of the Board of Water and Electric Light Commissioners in Lansing, Mich.

WILLIAM J. LARKIN, JR., is Secretary of the Wrought Steel Furniture Corporation of Chicago, Ill.

J. IRVING LEONARD has become Designing Engineer for the Public Utilities Commission of Newark, N.J.

WILLIAM H. WALKER, who was connected with the Merritt-Chapman and Scott Corporation of New York, is at present Assistant Engineer of Structural Design for the New York Edison Company.

G. A. UPDIKE has associated himself with the American Bridge Company of Ambridge, Pa.

EDWARD T. MURCHISON has accepted the position of Superintendent of the Engineering Section of the "Century of Progress, 1933" World's Fair in Chicago. He was Assistant Chief Engineer for the Krenn and Dato Construction Company of Chicago.

GROVER F. CONROY is with the Southwestern Portland Cement Company of El Paso, Tex.

ELLIOTT B. VAN HOOK has become associated with the Capitol Steel Corporation, Brooklyn, N.Y. He was previously with the Truscon Steel Company of Philadelphia, Pa.

F. A. LITTLE has become associated with the Indian Territory Illuminating Oil Company of Bartlesville, Okla.

BRONSON R. MAGEE is a member of the Engineering and Building Construction Division of Arthur G. McKee and Company of Cleveland, Ohio.

MIKISHI ABE is one of the consulting engineers for three electric railways, as well as for a construction company and a cement company, in Tokyo, Japan.

GEORGE F. WHITMARK, now with the Ford Motor Company in Albany, N.Y., was formerly connected with A. A. Brown and Company.

S. A. THOMAS, JR., has accepted the position of Assistant Engineer of Dam Inspection for the State of California.

JOHN E. JONES is Assistant Junior Engineer for the Ministry of Transport, London, Eng.

THEODORE W. SCHROEDER has left Spooner and Merrill, Inc., and has taken a position with the Subway Engineering Commission of Chicago, Ill., as a Subway Draftsman.

KINGSLEY B. WOODWORTH is at present Topographical Draftsman for the Long Island State Park Commission. He was formerly with New York Air Terminal, Inc.

LUTHER M. WINSOR, who was Project Engineer for the U.S. Biological Survey, Logan, Utah, is now Irrigation Engineer, U.S. Department of Agriculture, Bureau of Public Roads, in Utah.

WILLIAM H. WICK, one-time Assistant Engineer for the Utility Department, Tacoma, Wash., has joined the Cushman Power Project in Tacoma, as Principal Assistant Engineer.

MARVIN E. ROBERTS is now Resident Engineer for Freeland Roberts and Company in Nashville, Tenn. He was at one time Surveyman for the U.S. Engineering Office, Kansas City, Mo.

NATHAN EPSTEIN, who was connected with the Carson Construction Company, has become an Assistant Engineer for the Board of Transportation in Brooklyn, N.Y.

RAYMOND G. RIDGELY, formerly with Malcolm Pirnie, is now Superintendent of the Pinellas Water Company in St. Petersburg, Fla.

GEORGE A. SHERRON is Manager of the Rhinelander Real Estate Company of New York City.

HARRY STOCK, formerly an associate of the Adams Construction Company of Minneapolis, Minn., is now Construction Engineer for the Ernest M. Gaulay Company in the same city.

JAMES H. TEBBETS has left Charles T. Main, Inc., of Boston, Mass., and has joined the Vaughan Engineers.

KENNETH C. GRANT, who was president of Hamm, Grant, and Bruner, Inc., has recently been reelected president of the reorganized company of Grant and Bruner, Ltd., Los Angeles, Cal.

JOHN A. NORRIS has been reappointed Chairman of the State Board of Water Engineers of Texas.

B. F. WILLIAMS was elected President of the National Drainage, Conservation and Flood Control Congress, which will have its Twentieth Annual Session at Dallas, Tex. Mr. Williams is Reclamation Engineer for the State of Texas.

DON M. FORRESTER, formerly Engineer of tests for Walter H. Flood and Company, Jackson Miss., is now Chief Engineer of European Offices for the Seabrook Engineering Corporation of New York. Mr. Forester has returned to New York for a short while from his present station in Moscow.

WILLIAM D. WALTMAN, who represents the Franco Wyoming Oil Company, Franco Western Oil Company, McElroy Ranch Company and Isolantite, Inc., has transferred his general offices from New York to Los Angeles.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From March 10 to April 9, 1931

ADDITIONS TO MEMBERSHIP

ANDERSON, ROBERT ANGUS, JR. (Jun., Oct. '30.) 319 Henry St., East, Savannah, Ga.

BARBER, RICHARD. (Jun., Nov. '30.) Res. Engr., State Dept. of Highways, 1351 King St., Bellingham, Wash.

BARROWS, WILBUR RAYMOND. (Jun., Jan. '31.) Care, Middle Rio Grande Conservancy Dist., Belen, N. Mex.

BARTON, HARRY. (Jun., Feb. '31.) Gen. Mgr., New Jersey Water Service Co. and Federal Water Service Corp., 35 Lincoln Ave., Little Falls, N.J.

BECKLEY, CHARLES OWEN. (Jun., Nov. '30.) Insp., State Dept. of Highways, Alum Bank, Pa.

BECKWITH, EDWARD GIDDINGS. (M., Feb. '31.) Project Engr., Gen. Chemical Co., New York, N.Y.

BENDER, ELMER ALBERT. (Jun., Oct. '30.) Care, The Vang Constr. Co., 3022 Grant Bldg., Pittsburgh, Pa.

BENEDICT, TRUMAN GLENN. (Jun., Oct. '30.) Box 223, Brownsville, Tenn.

BENITEZ-GAUTIER, JOSÉ. (Assoc. M., Feb. '31.) Engr. and Contr., Benitez & Benitez Gautier, Box 218, San Juan, Porto Rico.

BICKHAM, HUNTER LINDSEY. (Jun., Nov. '30.) 3903 Junius St., Dallas, Tex.

BLODGETT, HOWARD BLAIR. (Assoc. M., Feb. '31.) Instr., Civ. Eng., South Dakota State Coll., Brookings, S. Dak.

BOBER, HANS FENWICK. (Assoc. M., Feb. '31.) 1631 North West 44th St., Oklahoma City, Okla.

BOSSEN, LESLIE EDWIN. (Jun., Feb. '31.) Junior Engr., Water Resources Branch, U.S. Geological Surveys, San Francisco, Calif.

BURLEY, EDWIN MAURICE. (Jun., Oct. '30.) 608 Douglas St., Wenatchee, Wash.

BUTLER, ROY GRAHAM. (Assoc. M., Feb. '31.) Asst. Engr., The Port of New York Authority, 80 Eighth Ave., Room 903, New York, N.Y.

CHRISTOPHERSON, FRITZ CONWAY. (Assoc. M., Jan. '31.) Associate Hydr. Engr., U.S. Geological Survey, Water Resources Branch, 506 Broadway-Arcade Bldg., Albany, N.Y.

CLARKE, ALFRED CARLETON. (M., Feb. '31.) Asst. Chf. Engr., B. & O. R. R., 337 Second Ave., Pittsburgh, Pa.

COX, LAWRENCE WILBUR. (M., Mar. '31.) Bridge Designer and Detailer, State Dept. of Public Works, Lincoln, Nebr.

DAVIDSON, HENRY ALEXANDER. (Jun., Dec. '30.) Engr., H. L. Wilson Co., Minneapolis, Minn.

DIEBOLD, FERDINAND HEIM. (Jun., Oct. '30.) R. D. 2, Fox Chapel Rod., Aspinwall, Pittsburgh, Pa.

DODGE, KEITH LAMAR. (Jun., Dec. '30.) Draftsman, C. E. Bazille, 617 South Olive St., Room 503, Los Angeles, Calif.

DUNNE, EUGENE ROBERT. (Assoc. M., Mar. '31.) Pres., Carman-Dunne, Inc., Professional Bldg., Lynbrook, N.Y.

FISHER, RALPH LASHER. (Jun., Mar. '31.) 624 Bloomfield Ave., Nutley, N.J.

ERICKSON, SWAN ARTHUR. (Assoc. M., Nov. '30.) Draftsman and Designer for State Engr., Phoenix, Ariz.

FOWLER, CHARLES WORTHINGTON. (M., Feb. '31.) Secy. and Chf. of Civ. Eng. Dept., United Porto Rican Sugar Co., Caguas, Porto Rico.

FRIEDMAN, HARRY. (Assoc. M., Feb. '31.) Contr. Engr., 2301½ West Vernon Ave., Los Angeles, Calif.

GIBBINGS, PERCY NICHOLAS, JR. (Jun., Nov. '30.) 2609 Villa Circle, Norfolk, Va.

GIERASCH, AIDEN REDMOND. (Jun., Dec. '30.) 483 Hamilton St., Albany, N.Y.

GIVENS, HARRISON CRANDALL, JR. (Jun., Oct. '30.) 63 North Emily St., Crafton, Pa.

GLASSBERG, MYRON. (Jun., Mar. '31.) Agt., Constr. Specialties, Louderman Bldg., St. Louis, Mo.

GUNN, JOHN WILFRED HARDY. (Jun., Dec. '30.) 1848 East 71st St., Los Angeles, Calif.

HARRINGTON, EARL WHITTEMORE. (M., Feb. '31.) Engr. in Chg., New York Office, Mfrs. Mutual Fire Insurance Co., 8 West 40th St., New York, N. Y.

HARVEY, ALFRED LAIRD. (Assoc. M., Mar. '31.) Res. Engr., A. D. Swan, Chicoutimi, Que., Canada.

HODGES, RUPERT GEORGE. (Jun., Nov. '30.) Beulah, Miss.

HOLLOWAY, LAMBERT ADKINS. (Jun., Oct. '30.) 4636 Oakland St., Philadelphia, Pa.

HOOD, RAYMOND ALOYSIUS. (Assoc. M., Feb. '31.) Insp. of Eng., Philadelphia Rapid Transit Co., Philadelphia, Pa.

JONES, CHARLES DORNBUSCH. (Assoc. M., Feb. '31.) Sales Engr., Am. Bitumuls Co., Baltimore, Md.

JOST, HERMAN HENRY, JR. (Jun., Nov. '30.) 626 North 33d St., East St. Louis, Ill.

KAPO, VINCENT. (Jun., Oct. '30.) 209 West Centre St., Mahanoy City, Pa.

KELLY, THOMAS ALFRED, JR. (Jun., Oct. '30.) Asst. Prof., Civ. Eng., Colorado School of Mines, Golden, Colo.

KLEIN, ALEXANDER. (Jun., Oct. '30.) Box 1505, Richmond, Calif.

LARSEN, WILLIAM SCHROEDER. (Assoc. M., Feb. '31.) Engr., City Engrs. Office, Tacoma, Wash.

LAWLER, PHILIP SYMMES. (Jun., Dec. '30.) Asst. Secy., Lauriston Investment Co., San Francisco, Calif.

LEAP, CLIFFORD RAYMOND. (Jun., Mar. '31.) 345 Sherwood Ave., Jeffersonville, Ind.

LILLY, SCOTT BARRETT. (M., Feb. '31.) Prof., Civ. Eng., Swarthmore Coll., Swarthmore, Pa.

LORD, ROY STANLEY. (Jun., Nov. '30.) Junior Engr., U.S. Geological Survey, 197 East 9th St., San Bernardino, Calif.

LOVETT, FRANK WILLIAM. (Assoc. M., Feb. '31.) Hotel Harper Crest, 54th and Harper Ave., Chicago, Ill.

MCBRIDE, JOHN. (Jun., Oct. '30.) 403 Curtis St., Middletown, Ohio.

MCCORMICK, ALEXIS. (Assoc. M., Feb. '31.) Res. Engr., State Highway Dept., Madisonville, Tex.

MCSWEENEY, JAMES JOSEPH. (Jun., Dec. '30.) 43 Mohican Park, Dobbs Ferry, N.Y.

MOORE, PERCY ELLIOTT. (Jun., Oct. '30.) Care, U.S. Engrs., 428 Customs House, St. Louis, Mo.

MORGAN, JOSEPH GUITON. (Assoc. M., Nov. '30.) County Engr., Travis County, Court House, Austin, Tex.

MORRISON, CLAUDE BENJAMIN. (Assoc. M., Feb. '31.) Senior Civ. Engr., Bureau of Eng., Los Angeles, Glendale, Calif.

MORSE, CLINTON. (Jun., Feb. '31.) Junior Engr., Panama Canal, Box 413, Balboa Heights, Canal Zone.

NELSON, ELMER JOHAN. (Assoc. M., Feb. '31.) Engr., Standard Oil Co. of California, Eng. Dept., 225 Bush St., San Francisco, Calif.

NIXON, SAM AB. (Jun., Oct. '30.) Room 407, Santa Fe Bldg., Galveston, Tex.

NUTTING, HORACE WINTER. (Assoc. M., Feb. '31.) Res. Engr., Hidalgo County Water Control and Impvt., Dist. 1, Edinburg, Tex.

PARK, JOHN CALLAWAY. (Assoc. M., Oct. '30.) Asst. Prof., Civ. Eng., Mines Bldg., Univ. of Arizona, Tucson, Ariz.

PHILPOTT, JAMES HENRY. (Jun., Mar. '31.) City Engr., City Hall, Wabash, Ind.

PILAND, JULIUS LYNCH. (Assoc. M., Nov. '30.) Care, M. Shapiro, 1560 Broadway, New York, N.Y.

POTTS, CHARLES ARLINGTON. (Jun., Feb. '31.) Constr. Draftsman, State Highway Dept., Macon, Mo.

PRICE, THOMAS MALCOLM, JR. (Jun., Oct. '30.) Care, U.S. Coast & Geodetic Survey, Washington, D.C.

PRITCHARD, LEROY EDWARD. (Jun., Oct. '30.) 2205 South 60th Court, Cicero, Ill.

RAMSEY, BEN ELKINS. (Jun., Nov. '30.) Care R. T. Wells, Empire Companies, Bartlesville, Okla.

REINHEIMER, JOSEPH PETER. (Assoc. M., Nov. '30.) Asst. City Engr., Springfield, Ohio.

RHODES, GEORGE IRVING. (M., Mar. '31.) Director, Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y.

ROSARIO, CRISANTO DIZON. (Jun., Dec. '30.) 309 Metropolitan Bldg., East St. Louis, Ill.

RUPKEY, ROBERT HARRY AYERS. (Assoc. M., Dec. '30.) Asst. Engr., U.S. Indian Irrig. Service, Box 445, Albuquerque, N. Mex.

SCHMIEDEKE, WILLIAM VALENTINE. (M., Feb. '31.) Vice-Pres. and Chf. Engr., The Penker Constr. Co., Cincinnati, Ohio.

SHAPIRO, WILLIAM. (Jun., Mar. '31.) Field Engr., Hart & Early Co., Inc., New York, N.Y.

SIEGEL, ABRAM. (Jun., Nov. '30.) 405 East Duffy St., Savannah, Ga.

SIMPSON, EMERSON EATON. (M., Feb. '31.) Supt. of Constr., U.S. Veterans' Bureau, Perry Point, Md.

SMITH, ELDRED DAVID. (Jun., Feb. '31.) Care U.S. Bureau of Reclamation, Denver, Colo.

SMITH, WILLIE WADE. (Jun., Mar. '31.) 1720 Euclid St., Washington, D.C.

STUREK, WALTER FRANK. (Jun., Nov. '30.) Care, Phillips Pipe Line Co., Bartlesville, Okla.

TRAINOR, CHARLES FRANKLIN. (Jun., Oct. '30.) Junior Engr., U.S. Engr. Office, Savannah, Ga.

WALSH, JOHN JOSEPH. (M., Feb. '31.) Watermaster, Dist. 7, Water Resources Dept., State of Oregon, Box 1025, Burns, Ore.

WASSER, CLARENCE FRANKLIN. (Assoc. M., Feb. '31.) Res. Engr., State Highway Board, 44 Brenau Ave., Gainesville, Ga.

WESTINGHOUSE, GEORGE FRANK. (Jun., Mar. '31.) Marion, Va.

WHITEHURST, HERBERT CLINTON. (M., Feb. '31.) Coordinator and Chf. Engr., Eng. Dept., District of Columbia, District Bldg., Washington, D. C.

WOOD, WILLIAM ALFRED. (Assoc. M., Feb. '31.) Office Engr., United Fruit Co., Santa Marta, Colombia.

MEMBERSHIP TRANSFERS

AEGERTER, WILLIAM CARL. (Jun., '26; Assoc. M., Feb. '31.) Structural Engr., Palmer Bee Co., Detroit, Mich.

ANGEN, JOHN HARRISON. (Jun., '24; Assoc. M., Nov. '30.) Asst. Engr., Office of Engr. of Structures, N.Y. C. R. R., 466 Lexington Ave., Room 932, New York, N.Y.

BENHAM, SANFORD WEAVER. (Jun., '26; Assoc. M., Mar. '31.) Box 911, Plainfield, N.J.

BISSELL, CHARLES ARTHUR. (Assoc. M., '19; M., Mar. '31.) Chf. Eng. Div., Bureau of Reclamation, U.S. Dept. of the Interior, Washington, D.C.

BLACKBURN, FRANCIS ELLIS. (Jun., '27; Assoc. M., Dec. '31.) City Engr., Box 637, Demopolis, Ala.

BRADSHAW, GEORGE WATSON. (Jun., '24; Assoc. M., Feb. '31.) Asst. Prof., Civ. Eng., 14 Marvin Hall, Univ. of Kansas, Lawrence, Kans.

BUCKLEY, THOMAS. (Assoc. M., '25; M., Mar. '31.) Asst. Chf. Engr., Bureau of Eng. and Surveys, Dept. of Public Works, 1102 City Hall Annex, Philadelphia, Pa.

DOYLE, WALTER HENRY. (Jun., '27; Assoc. M., June '30.) Engr. in Chg., Leonard C. L. Smith, 444 Jackson Ave., Long Island City, N.Y.

DUFFY, LEO JOHN. (Assoc. M., '27; M., Jan. '31.) Special Repr., Johns Manville International, 20 Benelong Crescent, Bellevue Hill, Sydney, N. S. W., Australia.

EVERETT, ROY EDWARD. (Jun., '25; Assoc. M., Jan. '31.) Designer, Allied Engrs., Inc., Jackson, Mich.

HOLT, TAYLOR, JR. (Jun., '25; Assoc. M., Oct. '30.) Chf. Engr., Southern Steel Products Co., Richmond, Va.

JONES, PUSEY. (Jun., '06; Assoc. M., '12; M., Mar. '31.) Structural Engr., The Cincinnati Union Terminal Co., 1020 Temple Bar Bldg., Cincinnati, Ohio.

KRANZ, HENRY HUGO. (Assoc. M., '19; M., Mar. '31.) Supt., Highway Maintenance, Dept. of Highways, City of Cincinnati, Cincinnati, Ohio.

LEE, DONOVAN HENRY. (Jun., '25; Assoc. M., Feb. '31.) Director, Eton Estates Ltd. & Domiciles, Ltd., 124 Baker St., London W. 1, England.

MCNAMEE, ROBERT LETTS. (Assoc. M., '25; M., Jan. '31.) Prin. Asst. Engr., Hoad, Decker, Shoecraft & Drury, State Savings Bank Bldg., Ann Arbor, Mich.

MYLCHREEST, GEORGE LEWIS. (Assoc. M., '25; M., Mar. '31.) Cons. Engr. and Archt., Mylchreest & Reynolds, 238 Palm St., Hartford, Conn.

NETHERY, GEORGE RAYMOND. (Jun., '23; Assoc. M., Nov. '30.) Gen. and Eng. Contr., W. J. Nethery & Son, 2759 Main St., Riverside, Calif.

NUBAR, YVES. (Jun., '28; Assoc. M., Mar. '31.) Structural Engr., H. G. Balcom, 10 East 47th St., New York, N.Y.

OGDEN, CHESTER WHITE. (Assoc. M., '20; M., Mar. '31.) Asst. Chf. Engr., Virginia Bridge & Iron Co., Roanoke, Va.

GOE, MILO FREDERICK. (Jun., '28; Assoc. M., Feb. '31.) Res. Engr., Ayres, Lewis, Norris & May, Cornwell Bldg., Ann Arbor, Mich.

PARKER, THEODORE BISSELL. (Assoc. M., '20; M., Mar. '31.) Project Engr., Stone & Webster Eng. Corporation, Boston, Mass.

RAGSDALE, FRANK VICTOR. (Assoc. M., '19; M., Mar. '31.) Proprietor, The F. V. Ragsdale Co., 818 Dermon Bldg., Memphis, Tenn.

RUPP, GEORGE WELLINGTON. (Assoc. M., '28; M., Jan. '31.) Cons. Engr., 921 First Ave., West, Seattle, Wash.

RUSSELL, VERNEY WARREN. (Assoc. M., '13; M., Mar. '31.) Irrig. Mgr., U.S. Bureau of Reclamation, Ellensburg, Wash.

SAGAL, MARCUS. (Jun., '24; Assoc. M., Mar. '31.) Constr. Engr., James Stewart & Co. Inc., New York, N.Y.

SCHLEGEL, GLENN MARCUS. (Jun., '28; Assoc. M., Mar. '31.) Shop Supt., Leetsdale Works, McClintic-Marshall Corporation, Leetsdale, Pa.

THOMPSON, ROBERT ANDREW, JR. (Jun., '25; Assoc. M., Feb. '31.) Res. Engr., Reservoir Dam, Brown County Water Impvt., Dist. 1, 604 Citizens National Bank Bldg., Brownwood, Tex.

WELLS, OSCAR. (Assoc. M., '28; M., Mar. '31.) Asst. Engr., The Cincinnati Union Terminal Co., 1020 Temple Bar Bldg., Cincinnati, Ohio.

WERMECKE, KASPER DE NYSSEN. (Jun., '24; Assoc. M., Feb. '31.) Insp., Cartiers Southern Ry., 303 Huffman St., Waynesburg, Pa.

REINSTATEMENTS

BURR, MYRON CARLOS, M., reinstated Apr. '31.

JENKINS, CHARLES EDWIN, M., reinstated Mar. '31.

KNOX, SAMUEL LIPPINCOTT GRISWOLD, M., reinstated Apr. '31.

RESIGNATIONS

FUECHSEL, CHARLES FREDERICK, Jun., resigned Mar. '31.

GILDERSLEEVE, GEORGE SNYDER, Assoc. M., resigned Apr. '31.

LANDAUER, LEO LEVY, Jun., resigned Mar. '31.

LINTON, JOSEPH WILLIAM, Assoc. M., resigned Mar. '31.

SANDSTON, LEONARD MARK, M., resigned Mar. '31.

TERRILL, MAURICE WILBUR, Jun., resigned Apr. '31.

DEATHS

ALLEN, ANDREWS. Elected M., Oct. 4, 1905; died Mar. 21, 1931.

EDDY, HAROLD MANSFIELD. Elected Assoc. M., Oct. 9, 1917; M., Jan. 20, 1922; died Nov. 9, 1930.

HASTINGS, HORACE MALCOLM. Elected Assoc. M., July 11, 1927; died Feb. 4, 1931.

MCDANEL, MAYNARD SARGENT. Elected M., Mar. 12, 1918; died Mar. 23, 1931.

STANNARD, JAY L. Elected M., Aug. 31, 1915; died Mar. 13, 1931.

TUCKER, LESTER WALDO. Elected M., Dec. 4, 1901; died Mar. 24, 1931.

WALLACE, ROBERT SMITH. Elected M., Nov. 14, 1927; date of death unknown.

WILLACKER, CHARLES EDWARD. Elected Assoc. M., Nov. 15, 1926; died Nov. 4, 1930.

WINTERMUTE, FRED CLARK. Elected Jun., July 1, 1909; Assoc. M., Nov. 4, 1914; died Jan. 26, 1931.

YAPPEN, ADOLPH. Elected Assoc. M., June 1, 1909; M., July 7, 1915; died Apr. 4, 1931.

TOTAL MEMBERSHIP AS OF APRIL 9, 1931

Members	5,844
Associate Members	6,260
Corporate Members	12,104
Honorary Members	16
Juniors	2,653
Affiliates	133
Fellows	7
Total	14,913

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; married; California license; B.S. degree; 10 years experience in design of reinforced concrete and structural steel office buildings, theater, factory, and club buildings. Location in the West preferred. Available at once. C-8959-313-A-7. San Francisco.

CIVIL ENGINEER; M. Am. Soc. C.E.; 46; graduate Purdue University; married; 22 years specialized experience in hydraulic dredging, harbor improvements, and bridge construction; 6 of these years in charge of construction of five bascule bridges for one municipality. Desires position with engineering firm or state highway department. Available within 30 days for United States. C-5875.

CONTRACTOR'S SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; graduate civil engineer; licensed professional engineer and surveyor; 7 years experience with general contractor. Has superintended construction of schools, factory developments, medical and office buildings. Experienced in estimating, also in design and construction of airports and their buildings. C-8571.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; 4 years construction experience with contractors on railroad work. Interested in working with small-scale contractor with view to buying the business. Location in small progressive town in Middle Atlantic States preferred. State particulars. C-2501.

SANITARY ENGINEER; Jun. Am. Soc. C.E.; 23; desires position in sanitary engineering field or instructorship in engineering. Received civil engineering degree in 1929 and will complete 2 years graduate work in sanitary engineering this June. Two years experience as part-time instructor and assistant. Available July 1. C-4700.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; single; graduate 1925; drafting and design of steel, concrete, and tile buildings for industrial plants and living quarters, pile foundations, and structures above water; supervision over designs in drafting rooms here and in tropics. Location immaterial; available immediately. C-8936.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; responsible position in New York desired; graduate; 10 years field and office engineering; 2 years other business experience. Previous employment with railroad systems, large oil corporation, steel fabricator, city, state, and Federal Government. Worked under supervision of prominent bridge engineers, noted engineering educator, and leading transportation consultant. C-6321.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; university graduate, 1928; 27; 3 months drafting; 3 months assistant estimator and designer; 2 years chief estimator and designer; will do any kind of work; available at once. Location in United States preferred. C-4609.

SANITARY ENGINEER; M. Am. Soc. C.E.; 39; married; graduate Massachusetts Institute of Technology; New Jersey license; 17 years experience with consulting engineers on state and municipal work, water supply, sewerage, public health, and flood control; has specialized in water supply investigations, reports, appraisals, rates, design estimates, specifications, construction, and operation. Location in New England or Middle Atlantic States. A-1869.

CIVIL ENGINEER; M. Am. Soc. C.E.; over 20 years experience; 4½ years construction large hydro-electric developments and estimating in power studies division; 8 years flood control, division engineer construction, surveys, and investigations; 6 years design and construction sanitary sewers, disposal plants, and paving projects; 3½ years railroad. Available short notice. C-5942.

FIELD ENGINEER; graduate; 31; married; 6 years experience with large construction company on structural steel and reinforced concrete buildings; 2 years experience in survey. Desires position with architect or contractor. Available at once. B-8365.

CIVIL ENGINEER AND PROMOTER; M. Am. Soc. C.E.; knowledge of the Orient from Yokohama to Karachi; free for new engagement soon. C-2148.

CIVIL ENGINEER; graduate, January 1930; 24; married; 1 year highway, field, and office experience as concrete and macadam pavement inspector, culvert inspector, plant inspector, instrumentman, and draftsman. Desires permanent connection with engineering, contracting, or industrial organization. Starting salary not the important feature. Location immaterial. C-8973.

ENGINEER; M. Am. Soc. C.E.; civil and industrial graduate; 20 years experience hydro-electric developments, power plants, industrial plants, housing developments. Capable of taking full charge, including engineering, architectural, and other subdivisions. Highest references. B-2835.

CIVIL AND HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; B.S. and C.E. degrees; 9 years experience investigations, reports, estimates, design of public utilities, and hydro-electric developments; 2 years foreign study. Speaks German, Swedish, Norwegian; knowledge of Spanish. Available immediately. Domestic or foreign. C-9013-313-A-9. San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate; 26; single; 4 years industrial building construction. Desires connection where experience will be of value, preferably with contractor, management or valuation engineer, or sales engineer of material or equipment company. Available at once. Location East, or travel. C-8971.

WATER SUPPLY DEVELOPMENT; M. Am. Soc. C.E.; registered professional engineer; broad experience in development of sources of water supply, planning, and construction. Available for consulting or permanent connection on problems resulting from recent droughts. A-5380.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; 20 years experience; high-grade residential, bank, church, railway building, power plant, industrial building, and heavy foundation construction, including estimating, outside supervising, appraising, and designing. Past 5 years, chief estimator, handling preparation of estimates, purchasing, outside supervision, negotiating with architects and owners. Location New York or Philadelphia. B-2775.

UNIVERSITY INSTRUCTOR; Jun. Am. Soc. C.E.; 26; advanced study in Mid-Western university; 3 years experience in highway construction, surveys, materials testing, inspection, and design; 2 years experience as assistant instructor; 2 years experience as instructor. C-9051.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 50; married; New York license; 21 years varied experience harbor works; 5 years real estate planning; 2 years factory planning, construction, and operation. Available on short notice. C-9049.

UNIVERSITY INSTRUCTOR; Assoc. M. Am. Soc. C.E.; desires position as assistant professor with opportunity to teach sanitary engineering; 9 years general engineering practice; 8 years teaching. Degree of M.C.E. in sanitary engineering, Cornell. B-7785.

CIVIL ENGINEER; M. Am. Soc. C.E.; broad experience on highway, road, and bridge work, highway location, and construction. B-7788.

REGISTERED CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; Protestant; graduate prominent Mid-Western university; desires position with engineering organization as designing draftsman or field engineer; 4 years experience in bridge building, construction, and design. Employed at present. Mid-West preferred but will go anywhere. C-8326.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 40; married; 15 years active engineering experience, field and office; design and construction power houses, industrial buildings, office buildings, tunnels, water works, and heavy foundations. Executive seeking responsible position. Able to direct and work independently. Good personality. Prefers East but will go anywhere. B-9576.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; married; graduate, University of Idaho; 1 year hydraulic work with U.S. Bureau of Public Roads; 1 year plate and structural detailing; 1 summer tank construction; 2 summers of railroad construction. Interested in any phase of hydraulic engineering. Prefers location in Pacific Northwest. C-6991-303-A-4. San Francisco.

DESIGNING ENGINEER AND CHIEF DRAFTSMAN; Assoc. M. Am. Soc. C.E.; 32; married; civil engineering graduate; 2 years sales engineer, steel; 1 year conveying machinery, design; 7 years dam design, estimating, power, water supply, and irrigation; thorough knowledge stress analysis, design details, airport design. Can write engineering articles and reports. Location and salary open. C-8989.

GRADUATE CIVIL ENGINEER; 12 years experience railway location, construction, plans, estimates, and maintenance; highway location and construction. General pioneer work on sugar in Central America. Chief construction engineer on 250-kilometer railroad job. Speaks Spanish; working knowledge of French. Has worked in tropics and the East. Location immaterial. Salary open. Available immediately. C-9088.

ENGINEERING EXECUTIVES; M. Am. Soc. C.E.; 25 years engineering, executive, and construction experience, municipal, highway, and allied lines. Responsible position desired. Middle States preferred. Available on short notice. C-8700.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; married; graduate, Brown University and Massachusetts Institute of Technology; available May 1 for responsible position; 20 years experience in structural steelwork, designing, estimating, and selling. C-9005.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; civil engineering degree from leading Eastern university; married; 6½ years broad experience with steel fabricators and engineers. Familiar with all classes of steel bridges and buildings. Desires position as structural designer, assistant engineer, or sales engineer. C-7922.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; 15 years engineering experience in Eastern countries as resident and contracting engineer, on docks, water works, and reinforced concrete work. Desires position in Eastern country, Egypt to Japan. C-8687.

CIVIL ENGINEER; M. Am. Soc. C.E.; 28 years experience on railways, water works, sewers, and lighting plants, in industrial, maintenance, and construction work, dock construction, pile bridges, valuation and appraisals, including management. Recently 3 years in South America. Desires connection with industry, utility, or railway. Registered engineer, Colorado. C-8695.

DIRECTOR OF ENGINEERING AND PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; desires similar position as head of department of civil or highway engineering or as dean in a recognized institution; exceptional record of 15 years practical experience; graduate Massachusetts Institute of Technology. Prefers East or Middle West. Trained executive. B-6574.

PATENT ATTORNEY; Assoc. M. Am. Soc. C.E.; desires to organize and manage patent department of corporation; C.E. degree; member New York Bar, U. S. District Bar; registered attorney, U. S. Patent Office; 5½ years with old established firm, patent attorney; before that 8 years engineering and management experience. Now in charge patent work large corporation. B-1819.

ENGINEER; Assoc. M. Am. Soc. C.E.; 36; registered engineer, Pennsylvania; licensed construction engineer and land surveyor, New Jersey; experienced in design and construction of industrial and commercial buildings, bridges, subway and elevated railways, municipal structures, and airports (site selection, grading, paving, drainage, lighting, and buildings); desires new connection, preferably Eastern United States. C-9131.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied and intensive experience in structural drafting and design of steel and concrete, in connection with subway construction, building design, and railroad work; familiar with field engineering construction; thorough, keen, alert; unlimited capacity to assume responsibility. Prefers field engineering construction work or connection with consulting engineer, contractor, or construction company, where ability is appreciated. C-2605.

ENGINEER; Assoc. M. Am. Soc. C.E.; M. Am. Soc. M.E.; 36; married; 15 years civil and mechanical engineering experience with various industries, particularly the manufacture and fabrication of steel; dependable estimates, specifications, designs, and inspection of all types steel structures, heavy machinery, and foundations; good personality; excellent references. Desires executive position. C-6061.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; M.S. degree; 6 years experience in irrigation, flood control, hydro-electric projects, and drainage; available at once to company desiring high type of man for economic, hydrologic, and hydraulic studies. Excellent references; location immaterial. C-4172.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 39; Pennsylvania registration; 13 years experience in building construction, commercial and industrial types, both concrete and steel; cost work, field superintendence, and office engineering, including design for general contractors, for industrial engineers, and for hospital. Available at once. Location desired, United States. C-5695.

CIVIL ENGINEER; 23; graduate, University of Utah; single; 3 years experience in highway location and construction; some experience in topographic mapping. References furnished upon request. Desires work in foreign country, preferably South America. Available on 2 weeks notice. C-8969.

CIVIL AND EXPLORATION ENGINEER; Assoc. M. Am. Soc. C.E.; University graduate; 39; married; registered civil engineer, California. Speaks Spanish and Russian fluently; 15 years foreign and domestic experience exploration, development oil fields, mines, highway, railroad location, construction, triangulation, topographical surveys. Excellent references. Available immediately. Prefers Southwestern United States or Latin America. Would consider any location. C-8944.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 to 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

CHEMISTRY OF ENGINEERING MATERIALS. By Robert B. Leighou. New York, McGraw-Hill Book Co., 1931. 684 pp., illus., diagrs., 8 × 6 in., cloth. $4.50.

An elementary textbook upon the chemical properties of the materials used in building and manufacturing, written for users of them rather than for the makers. Water, fuels, metals, foundry sands, building stones, cements, clay products, paints, and lubricants are treated. The new edition has been carefully revised and brought up to date.

DESIGNING HEATING AND VENTILATING SYSTEMS. By Charles A. Fuller. 3 ed. New York, Scientific Book Corporation, 1931. 244 pp., illus., diagrs., tables, 9 × 6 in., fabrikoid. $3.00.

A detailed explanation of the methods in general use by designers. The subject is discussed simply and practically, with a minimum of mathematics and the book, therefore, is useful for those without extensive technical training.

ELEMENTS OF ENGINEERING GEOLOGY. By H. Ries and Thomas L. Watson. 2 ed. New York, John Wiley and Sons, 1930. 411 pp., illus., maps, tables, 9 × 6 in., cloth, $3.75.

A textbook for engineering schools whose need is for a briefer course than *Engineering Geology*, by the same authors. Emphasis is placed on the practical applications of geology in highway construction, tunneling, quarrying, river improvement, and water supply. This edition has new chapters on the geology of reservoir and dam sites and on historic geology.

FIELD GEOLOGY. By Frederick H. Lahee. 3 ed. New York, McGraw-Hill Book Co., 1931. 789 pp., charts, illus., diagrs., tables, 8 × 5 in., leather. $5.00.

The new edition of this popular work has been revised and enlarged to include consideration of the new methods of research which have been developed since the last edition. Much material upon barometric and plane-table surveying has been added, and there are new chapters upon airplane, subsurface geologic, and geophysical surveying. The bibliography has also been made larger.

ORGANIZATION ENGINEERING. By Henry Dennison. New York, McGraw-Hill Book Co. 1931. 204 pp., 8 × 5 in., cloth. $2.00.

This book discusses the problems of group life and action and points out some of the conditions that are necessary for effective work by organizations. The characteristics of human nature, which must be understood by the manager, are surveyed, methods for guiding and increasing joint productivity are considered, and the principles of organization structure are set forth.

PROPERTIES AND MECHANICS OF MATERIALS. By P. G. Laurson and W. J. Cox. New York, John Wiley and Sons. 353 pp., illus., diagrs., tables, 9 × 6 in., cloth. $3.75.

This textbook is intended to combine, in a single course, the studies of engineering materials and of the mechanics of materials. The authors have endeavored to give the student a thorough knowledge of the fundamentals in the time usually allotted to these subjects, so that he will be able, later, to approach with confidence, specialized cases in practical work.

STANDARD FOUR-FIGURE MATHEMATICAL TABLES. By L. M. Milne-Thomson and L. J. Comrie. London and New York, Macmillan Co., 1931. 2 vols. 490 pp., diagrs., 11 × 8 in., cloth. $9.00.

This work is intended to provide a comprehensive table of the numerical values of the elementary functions that are in constant use in applications of mathematics in physics, engineering, and statistics. The tables are well printed and well arranged. A number of tables are included, which are usually not readily available, such as trigonometrical functions with the argument in radians, hyperbolic functions, inverse trigonometrical and hyperbolic functions, natural logarithms, and powers of e.

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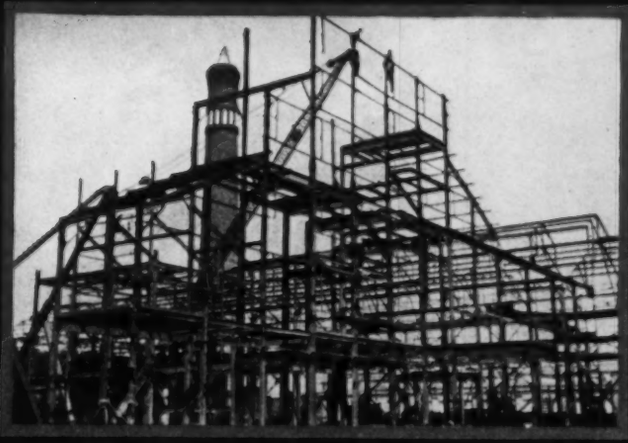

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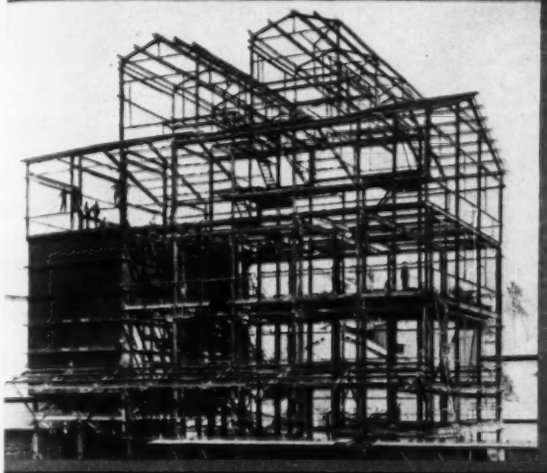

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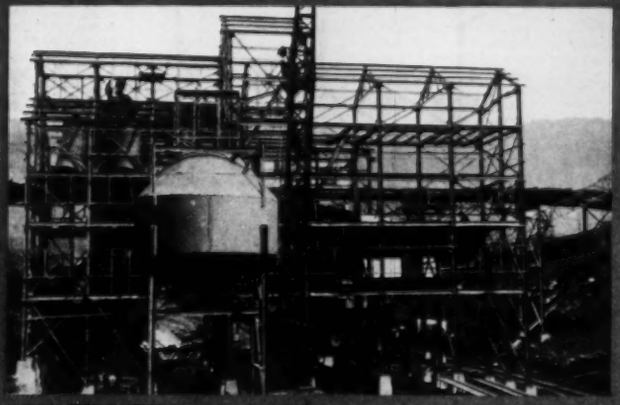

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BRIDGES

BASCULE, CHICAGO. A Complex Bridge-Moving Job, C. H. Mottier. *Ry. Age*, vol. 90, no. 9, Feb. 28, 1931, pp. 445–447, 6 figs. World's longest single-leaf bascule span shifted 400 ft. to accommodate channel change; two interrelated projects; trouble with sticking pins; rapid progress in re-erection.

CONCRETE, COSTS. Where Cost Economies Are Gained in Concrete Highway Bridges, C. B. McCullough. *Concrete*, vol. 38, no. 3, Mar. 1931, pp. 45–46. Reducing maintenance costs; field control of construction; how expansion joints may be avoided; life of structure depends on location; avoiding effects of inferior construction; amortization costs.

CONSTRUCTION. The Development of Bridge Construction, S. J. Crispin. *Machy. Market*, no. 1581, Feb. 20, 1931, pp. 19–21, 7 figs. Early examples of girder and suspension-type bridges; history of arch bridge; Menai tubular bridge; cantilever bridge. Before Junior Inst. Engrs.

FLOORS. Seattle Develops New Bridge Surfacing Method with Use of Asphalt, J. A. Dunford. *West. City*, vol. 7, no. 3, Mar. 1931, pp. 25–26, 2 figs. Use of asphalt as paving surface of West Spokane Street Bridge No. 2; steel subway flooring has top sheet rolled to compress material slightly below top of metal, to insure non-skid properties.

PLATE-GIRDER DESIGN. Stiffener Spacing for Plate-Girder Webs, O. E. Hovey. *Eng. News Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 446–447, 2 figs. Coefficient values for stiffener-spacing formula; Timoshenko's formula for elastic stability of web in girder; diagram for stiffener spacing.

STEEL ARCH, SYDNEY, AUSTRALIA. The Erection of the Main Span Cross Girders of Sydney. *Engineering*, vol. 131, no. 3399, Mar. 6, 1931, p. 337, 2 figs. Various operations in erection of girders, which are hoisted by creeper cranes by means of special lifting bracket.

Sydney Harbor Arch Erected in 22 Months. *Eng. News-Rec.*, vol. 106, no. 12, Mar. 19, 1931, p. 494. Discussion by L. Ennis of paper indexed in *Engineering Index* 1930 from issue of Oct. 23, 1930.

STEEL ARCH, UGANDA. The New Nile Bridge at Jinja. *Civil Eng. (Lond.)*, vol. 25, no. 9, Feb. 1931, p. 477, 1 fig. Description of new bridge in Uganda, provided with 20-ft. roadway for vehicular traffic suspended from top deck carrying railway, which consists of spandrel-braced arch 260 ft. in length, with two 100-ft. approach spans.

SUSPENSION, HUDSON RIVER. Cable Construction on Hudson River Bridge—I. *Construction Methods*, vol. 13, no. 3, Mar. 1931, pp. 60–61, 7 figs. Erection of footbridges illustrated in 7 photographs.

WIDENING. Famous African Bridge Altered Without Interrupting Traffic. *Eng. News-Rec.*, vol. 106, no. 10, Mar. 5, 1931, p. 398, 1 fig. Report on widening of deck of Victoria Falls Bridge, in Rhodesia, Central Africa, consisting of 500-ft. spandrel-braced arch; two railway tracks replaced by single line and roadway; change allows heavier wheel loads.

BUILDINGS

FIRE RESISTANCE. Recommended Minimum Requirements for Fire Resistance in Buildings. *U.S. Bur. Standards—Building and Housing*, no. 14, 1931, 58 pp., 4 figs. Sixth of series of reports prepared by Building Code Committee, which was appointed by Secretary Hoover in 1921 with object of determining basic requirements that could be recommended to insure public safety and at same time to promote economy in construction; recommended code requirements.

HIGH, CANADA. Canada's Greatest Building Achievement. *Contract Rec.*, vol. 45, no. 9, Mar. 4, 1931, 11 pp. between pp. 247–264, 13 figs. Design and construction of Canadian Bank of Commerce Building, with tower 27 stories high, springing from 7-story base that covers area of 149 ft. by 169 ft.; architectural features and description of heating and ventilating systems, service equipment, and vaults.

HIGH, ECONOMICS. Economic Factors of Building Heights, N. T. Whitmore. *Gen. Bldg. Contractor*, vol. 2, no. 2, Feb. 1931, pp. 23–30, 7 figs. Analysis of such factors as location, total investment, type of construction, foundations, wind bracing, elevators, total building cost, gross income, and operating expenses; effect of height on investment returns.

HIGH, FOUNDATIONS. Well-Point Drainage and 30-Hour Continuous Pour of Concrete on Building Foundation Job, S. I. Foster. *Contractors and Engrs. Monthly*, vol. 22, no. 3, Mar. 1931, pp. 65–67, 6 figs. Report on construction of foundation of 28-story addition to New York Telephone Company building, 24 Walker St., New York; underpinning existing building; concrete mat foundation poured in sections.

CITY AND REGIONAL PLANNING

PLANNING, NEW YORK. Group Planning of Commercial Building Gets First Major Tests in New York. *Eng. News Rec.*, vol. 106, no. 1, Mar. 12, 1931, pp. 455–456, 3 figs. Work on "Metropolitan Square," or "Radio City," project covering three blocks and involving about a dozen large buildings—one larger than Empire State—to start in June; cost to be $250,000,000.

CONCRETE

CONSTRUCTION, SLOPES. The Technic of Placing Concrete on Steep Slopes Without Forms, I. E. Burks. *Eng. Jl.*, vol. 14, no. 3, Mar. 1931, pp. 160–162, 8 figs. Practice at Chute à Caron on curved surfaces of slopes up to 50 deg.; stiff mixtures were used, requiring vigorous tamping when being placed; surface was shaped by use of screeds placed so that bottom edges of screeds represented finished surface of concrete; reduction in construction cost of gravity dams.

FORMS. Form Details and Practice Developed for Architectural Concrete. *Concrete*, vol. 38, no. 3, Mar. 1931, pp. 39–42, 6 figs. Use of fiber board lining; waste molds and their manufacture, use, and removal; proper proportions imperative in architectural concrete; reproduced from reprint, *How to Save in Concrete Form Work* (Concrete Publishing Company).

MIXING. Some Notes on Proportioning Concrete, H. J. Vogan. *Instn. Engrs. Australia—Jl.*, vol. 3, no. 1, Jan. 1931, pp. 1–15, 25 figs. Résumé of theories for concrete design; results of tests bearing on these theories carried out in Civil Engineering laboratories of Peter Nicol Russell School of Engineering, University of Sydney, Australia.

PAVEMENTS. Curing Concrete Pavement Bases. *Pub. Works*, vol. 62, no. 3, Mar. 1931, pp. 19–20. Practice of several hundred cities in all parts of United States, as indicated by recent information from officials; ponding, sprinkling, and other uses of water; covering with earth, burlap, or asphalt; use of chemicals; percentage of cities reporting from each section as using each of several methods of curing.

CONSTRUCTION INDUSTRY

COSTS. Unit Bid Summary. *West. Construction News*, vol. 6, no. 5, Mar. 10, 1931, pp. 58, 60, 62, 64, and 66. Unit prices bid on irrigation and reclamation works; bridges and culverts, water supply systems, street and road work in California, Nevada, Oregon, and other Western states.

GREAT BRITAIN. The Engineering Outlook—Constructional Engineering—X. *Engineering*, vol. 131, no. 3399, Mar. 6, 1931, pp. 334–335. Data on production, markets, and employment in construction and general engineering industries.

RESEARCH. Library and Intelligence Service at the Building Research Station. *S. African Engr. and Elec. Rev.*, vol. 21, no. 153, Jan. 1931, pp. 17 and 19. Useful purpose is served by this station, opened by British Department of Scientific and Industrial Research; building science abstracts are issued.

DAMS

CONCRETE ARCH, OREGON. Cableway Bucket Concretes Owyhee Dam at Rate of 1,000 Cu. Yd. per Shift. *Construction Methods*, vol. 13, no. 3, Mar. 1931, pp. 34–38, 10 figs. Bucket with capacity of 8 cu. yd. moving across dam site on end of 400-ft. vertical cable is depositing 1,000 cu. yd. of concrete per shift in arched gravity dam, 530 ft. high, being built for U. S. Bureau of Reclamation; foundation treatment; concrete mixing plant; cableway bucket is operated by worker who rides on it.

CONCRETE ARCH, WASHINGTON. Ariel Dam—An Example of Modern Dam-Construction Practice. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 435–438, 3 figs. Construction of concrete arch dam having maximum height of 313 ft. above foundation which is as deep as 125 ft. below stream bed; final location based on 26,000 ft. of drill-hole exploration.

CONCRETE, CONSTRUCTION. Methods Used in Bearing Certain Large European Dams, E. Constam. *Compressed Air Mag.*, vol. 36, no. 3, Mar. 1931, pp. 3420–3423, 11 figs. Notes on recent practice in France, Spain, and Switzerland.

Placing 350,000 Cu. Yd. of Concrete in Ariel Dam, W. A. Scott. *Concrete*, vol. 38, no. 3, Mar. 1931, pp. 13–16, 3 figs. Construction of concrete arch dam on Lewis River, in Washington; three 2-yd. mixers; aggregates produced on site and all sizes up to 6 in. utilized; fill 2-ft. construction joints after concrete shrinks.

CONCRETE, DESIGN. Problems in Concrete Dam Design, D. C. Henny. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 431–435, 1 fig. Discussion of uplift; prevention of cracks and heat control; cement specifications for mass concrete need revision; precast block construction offers distinct advantages.

CONCRETE GRAVITY, WASHINGTON. Easton Dam, Yakima Project, Washington, G. C. Imrie and A. A. Whitmore. *New Reclamation Era*, vol. 22, no. 3, Mar. 1931, pp. 54–56, 3 figs. Design and construction of gravity-type concrete structure, 248 ft. long and 66 ft. maximum height; spillway section is 64 ft. long and is provided with 64-ft. by 14½-ft. structural steel floating drum gate; care of river during construction; foundation excavation and grouting; concreting; erecting drum gate and wall plates.

GRAVITY, UPLIFT PRESSURE. Under-Pressure and Curvature in Gravity Dams, J. Husband. *Structural Engr.*, vol. 9, no. 3, Mar. 1931, pp. 100–116 and (discussion) 116–118, 15 figs. Consideration of uplift in design of British dams; methods of preventing or relieving under-pressure; leakage through superstructure; curvature in plan of gravity dams.

HOOVER DAM PROJECT. Construction Starts Soon on Hoover Dam. *Power*, vol. 73, no. 11, Mar. 17, 1931, pp. 432–436, 6 figs. After nearly 10 years of effort by Federal Government and other agencies, actual construction on Hoover Dam project, formerly known as Boulder Dam, is about to begin; contract for construction was let on Mar. 11; project will be constructed in Black Canyon, on Colorado River, and will comprise dam 730 ft. high, that will form storage reservoir of 30,500,000 acre-ft., with power plant of about 1,000,000 hp. installed capacity; rock

Architects: SHREVE, LAMB AND HARMON, New York City. General Contractor: Charles T. WILLS, INC., New York City.
Engineer: H. G. BALCOM, New York City.

and earth cofferdams; map showing Colorado River basin and location of Hoover Dam project; discharge of Colorado River tributaries.

Load Distribution in Hoover Dam. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, p. 454. Letter to Editor, by S. Johnston, discussing paper indexed in *Engineering Index* 1930, from issue of Dec. 25, 1930, under heading Boulder Dam Project.

HOOVER DAM PROJECT, CONTRACTS. Hoover Dam Unit Bids Submitted March 4 at Denver. *West. Construction News*, vol. 6, no. 5, Mar. 10, 1931, pp. 122–123. List of unit costs bid by successful bidders.

FLOOD CONTROL

FLOOD CONTROL, MISSISSIPPI RIVER. Jadwin Plan for Mississippi Flood Control Approved by Chief of Engineers. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 448–450, 1 fig. No economic justification for greater expenditure; narrower floodways and channel rectification warrant study; reservoirs and higher levees regarded unfavorably; United States should be held free of expense for flowage rights and flood damages; map of levee and diversion system of Mississippi flood control adopted by act of Congress, approved May 15, 1928.

FLOOD CONTROL, SURVEYING. Making Rapid Field Examinations of Flood-Control Reservoir Sites, J. A. Holmes. *Eng. News-Rec.*, vol. 106, no. 10, Mar. 5, 1931, pp. 386–388, 4 figs. Methods used to secure physical and economic data on 14 dams and 6 river systems in Mississippi Valley; river surveys.

FLOOD CONTROL, TEXAS. Storm and Flood Protection at Port Arthur, Tex., J. B. Converse. *Eng. News-Rec.*, vol. 106, no. 12, Mar. 19, 1931, pp. 487–489, 6 figs. Construction of water-front wall of concrete and steel sheeting with grouted and welded joints on shore of Sabine Lake; earth levees surround city; storm-water drains and pumping stations provided to handle interior drainage.

LEVEES, CONSTRUCTION. Notable Performance in Emergency Levee Building, T. H. Jackson. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 450–451. In Vicksburg engineer district, four-tower excavators with supplementary tractor wagon-grader outfit built six miles (3,428,956 cu. yd.) of full-section levee in five months.

FLOW OF FLUIDS

CURVED CHANNELS. Curvature Effects in Alluvial Channels, H. Chatley. *Engineering*, vol. 131, nos. 3396, and 3397, Feb. 13, 1931, pp. 196–197 and Feb. 20, pp. 260–261, 4 figs. It is claimed that on subject of changes of form and stability of section at curve in channel with mobile bed, no fully rational laws have been found, and empirical rules given by different authorities do not agree among themselves; in studying curves in Wangpoo River, author's attention has been particularly called to this discrepancy; generalized parabola sections of straight reaches; mechanics of flow around curves. Comparison of channel bends with pipe bends; transverse slope in alluvial channels.

FOUNDATIONS

CAISSONS, HINGED. Hinged Dock Caisson for India. *Engineer*, vol. 151, no. 3919, Feb. 20, 1931, p. 221. Curious caisson for closing end of drydock has been built and dismantled for shipment to India, where it will be reerected at site. Designed and made at Barrow Works by Vickers-Armstrongs, Ltd. It is furnished with a hinge, so that it can be opened and closed like a door, and is believed to be the third one of its type constructed.

COLUMNS, FOOTINGS, DESIGN. Strain Tests on Steel Plates Carrying H-Section Columns, G. C. Priester and C. H. Sandberg. *Eng. News-Rec.*, vol. 106, no. 12, Mar. 19, 1931, pp. 482–483, 4 figs. Investigation at University of Minnesota indicates major portion of load is transferred along column flanges and that plate contact area depends on elasticity of foundation; contour lines for steel plates on concrete, and on yielding bases.

MARINE STRUCTURES. Monolith Foundations, H. C. Reid. *Engineer*, vol. 151, no. 3920, Feb. 27, 1931, pp. 248–249. Monolith foundations for heavy walls are now almost universal, and practically every problem on great marine engineering works has been solved by use of that type of foundation. Monoliths are constructed of concrete and form, when completed, one solid mass and may have from one to four pockets or "wells," extending throughout their length. Before Junior Instn. Engrs.

PILES, FORMULAS. The Bearing Power of Piles. *Surveyor*, vol. 79, no. 2041, Mar. 6, 1931, pp. 311–313. Examination of best known formulas, their derivation, and comparison in actual cases with formula suggested by author.

ROADS, CONCRETE. Mud Pump Raises Settled Slab in Iowa. *Construction Methods*, vol. 13, no. 3, Mar. 1931, p. 39. Mud pump forces grout-like mixture of earth, cement, and water through holes drilled in settled pavement, raising slab and filling all voids.

UNDERPINNING. Shoring and Underpinning, H. C. Beck. *Gen. Bldg. Contractor*, vol. 2, no. 3, Mar. 1931, pp. 24–31, 10 figs. Review of modern methods with many examples from actual practice; description of patented steel drum for deep trench work.

VIBRATIONS. Ein Schwingungs-Erreger und Messer zur Dynamischen Baugrundpruefung. Seine Theorie und Adwendung (Theory and Use of Vibration Instrument for Dynamic Testing of Foundation Sites), P. Mueller. *Bauingenieur*, vol. 12, nos. 3 and 4, Jan. 16, 1931, pp. 43–47, and Jan. 23, pp. 70–74, 11 figs. Description of instrument, known as "geodyn," for excitation and measurement of vibrations; elasticity of ground; results of field experiments. Bibliography.

HYDRAULIC ENGINEERING

ROAD CONSTRUCTION, RIVER DIVERSION. Michigan Diverts River to Reroute Road, R. O. Van Orden. *Construction Methods*, vol. 13, no. 3, Mar. 1931, pp. 54–56, 8 figs. Development and improvement of U.S. Highway No. 12 from Detroit to Benton Harbor, Mich.; changing of Kalamazoo River in two places; creation of 15-acre lagoon; construction of new three-span bridge; and protection of water rights of property owners whose land adjoins river.

HYDRO-ELECTRIC POWER PLANTS

BRITISH COLUMBIA. Ruskin Hydro-electric Development of the British Columbia Power Corporation, C. E. Blee. *West. Construction News*, vol. 6, no. 5, Mar. 10, 1931, pp. 127–135, 13 figs. Description of project involving construction of overflow gravity-type diversion dam, 195 ft. high, intake, and two 21-ft. diameter penstock tunnels; power-house with initial space for two 47,000-hp. units; two transmission circuits to Vancouver; excavation; pouring of concrete; foundation grouting and drainage; electrical equipment; construction equipment and operating machinery required.

CHUTE À CARON, CANADA. The Chute à Caron Hydro-Electric Development, J. W. Rickey. *Engrs.' Soc. West. Penn.—Proc.*, vol. 47, no. 1, Jan. 1931, pp. 1–43, 29 figs. Full report on construction of hydraulic structures with special reference to concreting equipment and procedure; details of construction of diversion dam by tipping of reinforced concrete obelisk built on pedestal, on shore of Saguenay River, and installation of electric equipment. Bibliography.

The Design of the Chute à Caron Diversion Canal, G. O. Vogan. *Eng. Jl.*, vol. 14, no. 3, Mar. 1931, pp. 163–170, 8 figs. Diversion and control of Saguenay River during construction period; flood conditions as they affected cofferdam and other structures; hydraulic structures were carried out as to flow in diversion canal and in tailrace; difficulties with concrete lining due to high velocity and turbulent flow in tailrace; from August 1 to September 1 flows varying from 70,000 to 100,000 sec-ft. passed Chute à Caron.

ONTARIO. The Alexander Power Development on the Nipigon River, T. H. Hogg. *Eng. Jl.*, vol. 14, no. 3, Mar. 1931, pp. 147–159, 16 figs. Description of 54,000-hp. hydro-electric plant built by Hydro-Electric Power Commission of Ontario; main dam is semi-hydraulic fill, 90 ft. maximum height; spillway capacity is 30,000 sec-ft.; description of fish ladders and log slides; details of three 18,000-hp. Francis turbines and of generators of welded structural steel design rated at 15,000 kva., 12,000 volt, 3 phase, 60 cycle, 100 r.p.m.; power is transmitted by three 110-kv. lines to Port Arthur.

INLAND WATERWAYS

ST. LAWRENCE RIVER. The St. Lawrence. *Engineering*, vol. 131, no. 3398, Feb. 27, 1931, pp. 287–288, 1 fig. Review of complicated question of waterway and power project; work of Commission appointed by Governor Roosevelt; its Engineering Board proposes single development located at Massena Point; plan involves rock-fill dam closing main channel of river and two smaller dams shutting off narrower channels; feature of scheme is spillway dam with power plants at each end. It is claimed proposals might easily involve protracted negotiations between state and Federal governments, before proposals could be laid officially before Canada.

UNITED STATES. America's "Five-Year Plan," D. B. Robertson. *Ry. Age*, vol. 90, no. 10, Mar. 7, 1931, pp. 483–488. Characterization of government waterway venture as "five-year plan" in contending that waterway need is illusory; present policy of subsidization condemned; land grants and taxes; inland waterways corporation deficit; concealed taxes exceed freight charges; extravagant claims of savings.

IRRIGATION

OREGON. Economic Aspects of Land Reclamation in Eastern Oregon, J. T. Jardine. *Eng. News-Rec.*, vol. 106, no. 11, Mar. 12, 1931, pp. 441–443, 3 figs. Excellent soil, adequate water supply, and established communities are among physical advantages; markets for principal products are rapidly expanding; expert opinion on financial soundness indicates terms can be met.

MATERIALS TESTING

BRICK CONSTRUCTION. Strength of Brick and Tile Pilasters Under Varied Eccentric Loading, J. R. Shank and H. D. Foster. *Ohio State Univ. Studies—Eng. Experiment Station—Bul.*, no. 57, 1930, 51 pp., 26 figs. Tests of 16 full-sized pilasters of three kinds—all tile construction, all brick construction, and brick and tile construction—showed that strength of pilaster under eccentric load is less than that under uniform load and that relation between two strengths depends upon stiffness of construction and ability of material to absorb eccentricity of loading.

BUILDING MATERIALS. Testing Building Materials, T. Crane. *Bldg. Contractor*, vol. 2, no. 2, Feb. 1931, pp. 59–68, 13 figs. Review of modern methods of testing concrete aggregates, brick, and other building materials for strength, fire resistance, and permeability.

COLUMNS, STEEL, WELDED. Compressive Tests of Jointed H-Section Steel Columns, J. H. Edwards, H. L. Whittemore, and A. H. Stang. *U. S. Bur. Standards*—Jl. Research, vol. 6, no. 2, Feb. 1931, pp. 305–337, 36 figs. Investigation undertaken to determine, experimentally, distribution of stress near ends of columns and in bearing plates; specimens consisted of two 3-ft. lengths of H-section steel columns of unequal depth placed end to end with flat steel plate between them. Compressive loads were applied in direction of axes of columns. Effect of differences in depth of columns and their arrangement and of differences in thickness of bearing plates was also studied.

CONCRETE. Current Concrete Investigations Discussed by A.C.I. *Eng. News-Rec.*, vol. 106, no. 10, Mar. 5, 1931, pp. 402–404. Milwaukee meeting of American Concrete Institute deals with durability, strength, and cost; first report of steady-load tests of columns shows progressive load transfer from concrete to steel; separating coarse aggregate into two sizes is found economical; studies of mixer operation; workability, waterproofing, and admixtures; compression flow in cylinders and columns.

LABORATORIES, EUROPE. European Laboratories for the Testing of Materials, F. L. Everett. *Mech. Eng.*, vol. 53, no. 3, Mar. 1931, pp. 201–204, 5 figs. Observations covering important British and Continental university and industrial laboratories devoted principally to research in mechanics of materials.

MACHINES. Testing Machines and Their Applications, P. F. Foster. *Machy. (Lond.)*, vol. 37, no. 960, Mar. 5, 1931, pp. 729–732, 9 figs. Fundamentals of tensile-testing methods with data on dimensions of test pieces; typical stress-strain curves for various materials.

METALS. Creep of Metals at Elevated Temperatures, P. G. McVetty. *Fuels and Furnaces*, vol. 9, no. 3, Mar. 1931, pp. 317–319. Flow of metals under stress at elevated temperatures; metallurgical significance of creep phenomena. Before Nat. West. Metal Congress.

RUBBER. The Control of Uniformity of Press Cures, H. G. Bimmerman. *India-Rubber Jl.*, vol. 81, no. 10, Mar. 7, 1931, pp. 9–10. Physical Testing Committee of Rubber Division, Am. Chem. Soc., has made extensive study concerning proper method of securing correct results in testing of rubber; piping from supply to press; care in matter of insulation; temperature regulator bulb; care essential in setting up-presses.

PORTS AND MARITIME STRUCTURES

DOCKS, CONSTRUCTION. The Sinking of Trial Monoliths for King George's Dock Calcutta, J. MacGlashan. *Instn. Civil Engrs.—Excerpts Min. of Proc.*, vol. 23, no. 4740, 1930–31, 20 pp., 5 figs. Early history of improvements in Port of Calcutta; engineering principles and method of construction of new dock system; form and dimensions of monoliths, shoes of monolith curves, method of sinking, position of culverts, sluices, and other details; sinking of three trial wells as start on program of construction of new dock system.

TERMINALS, OPERATION. Marine Terminal Design from the Operating Point of View—I, F. R. Harris, H. E. Stocker, W. B. Ferguson, and R. F. Bessey. *Mar. Rev.*, vol. 61, no. 3, Mar. 1931, pp. 26–30, 6 figs. Considerations involved in marine terminal design emphasize that correct solution of problem involves, principally, economics of successful operation; terminals link transportation; guard against obsolescence; water areas and slips; slip widths for handling; tug service is required; short piers not desirable. Before Soc. Terminal Engrs.

RAILROADS, STATIONS, AND TERMINALS

AIR CONDITIONING. Heating and Air Conditioning the Cleveland Union Terminal, J. W. Carrow. *Heat, Piping and Air Conditioning*, vol. 3, no. 3, Mar. 1931, pp. 219–224, 5 figs. Ventilation of new Cleveland terminal and complete air conditioning systems for dining room, lunchroom, and barber shop; general service refrigeration; air-conditioned display cases in candy shop, food shop, and drug store. (Concluded.)

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BUILDINGS, SPECIFICATIONS. Report of the Committee on Buildings. *Ry. Age (Daily Edition)*, vol. 90, no. 10C, Mar. 12, 1931, pp. 528-D83–84, (including discussion); see also *Am. Ry. Eng. Assn.—Bul.*, vol. 32, no. 334, Feb. 1931, pp. 547–605, 41 figs. Includes structural welding, elevators, and specifications for metal buildings and concrete. Before Am. Ry. Eng. Assn.

CINCINNATI, OHIO. Union Station Project Involves Six Million-Yard Grading Job. *Ry. Age*, vol. 90, no. 19, Mar. 7, 1931, pp. 490–493, 6 figs. Contractor employs three shovels with 8-yd. dippers to fill site of new Cincinnati terminal which covers 240 acres; general shifting of facilities; use of explosives; diagram map of terminal showing new facilities; transportation plan.

TERMINALS. Report of Committee on Yards and Terminals. *Ry. Age*, (Daily Edition), vol. 90, no. 10C, Mar. 12, 1931, pp. 528-D79–81, including discussion. Hump yard design; maintenance of track scales; parking facilities at passenger stations. Before Am. Ry. Eng. Assn.

ROADS AND STREETS

ASPHALT. Experiments with "Colas" Emulsified Asphalt on California Highway Near Truckee. *West Construction News*, vol. 6, no. 5, Mar. 10, 1931, pp. 136–138, 6 figs. Results obtained on 10 miles of experimental road surface between Truckee and Nevada state line, near Reno; built by California Division of Highways in cooperation with U.S. Bureau of Public Roads.

BRICK. Costs and Methods on a Brick-on-Concrete-Base Highway in Niagara County, N.Y., R. M. Rumsey. *Contractors and Engrs. Monthly*, vol. 22, no. 1, Jan. 1931, pp. 87–89, 7 figs. Construction of road near Niagara Falls, N. Y., 3.80 miles long and 20 to 42 ft. wide; design and quantities; novel transverse expansion joints; rapid progress on excavation and base; curbing; batching system; curing; placing brick construction and equipment; experimenting to prevent excess asphalt on surface.

CONCRETE, CONSTRUCTION. Laying Twenty-five Hundred Yards of Concrete a Day, S. P. Longstreet. *Pub. Works*, vol. 62, no. 3, Mar. 1931, pp. 30–32, 11 figs. Description of methods and equipment used in constructing 5½ miles of concrete pavement between Finch Hill and Montdale, Pa.; work done in 80 per cent of contract time.

Novel Features of a 2-Strip Concrete Paving Job in the West Virginia Mountains. *Contractors and Engrs. Monthly*, vol. 22, no. 1, Jan. 1931, pp. 75–78 and 80, 10 figs. Construction of 10 miles of 18-ft. concrete pavement near Clendenin, W.Va.; special features of job included: central mixing plant; unique batcher set-up; turntable besides finished grade; traffic over turntable; only one finishing machine; burlap carried in rolls.

Rebuilding an Old Railroad Grade into a Modern Highway, H. J. Spelmann. *Cornell Civil Engr.*, vol. 39, no. 6, Mar. 1931, pp. 137–139 and 154, 2 figs. Construction of road, 12.8 miles long, on old grade of Chesapeake and Ohio Railway, between Culloden and Barboursville, W.Va., grading and drainage construction; construction of 20 ft. of concrete pavement; costs including landslide prevention work.

CONSTRUCTION, GREAT BRITAIN. The Great North Road Over the Grampians, R. Bruce. *Instn. Civil Engrs.—Excerpts Min. of Proc.*, no. 4812, 1931, 20 pp., 7 figs., some on supp. plate; see also *Quarry and Roadmaking*, vol. 36, no. 409, Mar. 1931, pp. 133–134. Reconstruction of trunk road from Inverness to near Blair Atholl in Perthshire, having length of about 78 miles, to standard suitable for modern traffic requirements; formation of new carriageway, 18 ft. wide, consisting of 3 in. of gravel sub-foundation, on which are laid 9 in. of hand-set blackstone pitching, which supports 3 in. consolidated thickness of bituminous macadam surfacing.

CONSTRUCTION, IOWA. Highway Blasted Out of Solid Rock Bluff Face, F. H. Mann. *Highway Engr. and Contractor*, vol. 38, no. 9, Mar. 1, 1931, pp. 45–47, 3 figs. Construction of Iowa United States Highway No. 55, blasted out of solid rock face of river bluff below McGregor, in Clayton County; cost $591,201.

CONSTRUCTION, SWAMPS. Steam Shovel in Peat Swamp and Machine Spreading of Sand and Chips. *Contractors and Engrs. Monthly*, vol. 22, no. 3, Mar. 1931, pp. 56–59, 9 figs. Features of bituminous macadam contract near Middleborough, Mass.; peat removed with track-laying steam shovel; no hand labor used in casting of sand binder on bottom course of coarse stone and ¾ in. chips on penetrated top course; base, top, and asphalt kept close together.

DESIGN. The Ditchless Road, D. S. Humphrey. *Highway Engr. and Contractor*, vol. 38, no. 9, Mar. 1, 1931, pp. 48–49. Deep side ditches cause most road accidents; it is practical to construct tile drains or shallow depressions along highways, so that whole right of way, between property lines, will be safe for automobile traffic at not greater first cost and for less maintenance afterward.

DRAINAGE. Need of Adequate Drainage of Road Bed, J. M. Empey. *Can. Engr.*, vol. 60, no. 9, Mar. 3, 1931, p. 80. Methods necessary to obtain maximum stability under different climatic conditions; conditions necessary for stability; construction of culverts. Before County and Township Engrs. and Superintendents, Ontario.

EARTH. Sand-Clay Road Construction, C. M. Strahan. *Highway Engr. and Contractor*, vol. 38, no. 9, Mar. 1, 1931, pp. 35–40, 17 figs. Classification and characteristics of acceptable road soils; analysis of sand clay, top soil, and semi-gravel road soils; construction methods; Georgia cost data for mileage of 215.

EARTH, MAINTENANCE. Oil-Penetrated Earth Roads at Four Cents a Yard, W. W. Shelby. *Eng. News-Rec.*, vol. 106, no. 12, Mar. 19, 1931, pp. 478–480, 2 figs. New procedure involving salvage of old oil mat has reduced retreatment costs, in Los Angeles County, to less than one-half cent per sq. ft.; selection of oil; surfacing costs.

GRADING. Heavy and Light Grading, with Specifications, L. G. Holleran. *Highway Engr. and Contractor*, vol. 38, no. 9, Mar. 1, 1931, pp. 41–44 and 49, 4 figs. Clearing; preserving natural features; cleaning up; stripping and storing top soil; excavation and embankment; earth excavation.

Use of Equipment on Grading Work, B. H. Petty. *Highway Engr. and Contractor*, vol. 38, no. 9, Mar. 1, 1931, pp. 31–34, 8 figs. Team versus mechanical power; excavating equipment; settlement of fills; hauling equipment.

HIGHWAY ADMINISTRATION, CANADA. Ontario Township Highway Activities, J. L. Prendergast. *Can. Engr.*, vol. 60, no. 9, Mar. 3, 1931, p. 89. Duties of road superintendent and selection of patrolmen. Before County and Township Engineers and Superintendents, Ontario.

LOW-COST. Low-Cost Road Surfaces, R. M. Lee. *Contract Rec.*, vol. 45, no. 9, Mar. 4, 1931, pp. 242–244, 3 figs. Various types of inexpensive pavements that give high traffic service; dust layers; bituminous surface treatment; gravel mulch; plant mixed gravel mulch; trade preparations; retreads; hot mixed gravel asphalt.

MATERIALS, SPECIFICATIONS. Bituminous Road Binders in Germany. *Surveyor*, vol. 79, no. 2041, Mar. 6, 1931, p. 314. New standards for bituminous materials used in road work, including mixtures of anthracene oil with pitch, so designed as to produce materials corresponding to refined tars in ascending order of pitch content, from 50 to 70 per cent.

PAVEMENTS, ASPHALT, OREGON. City of Ashland Finds Emulsified Asphalt Paving Economical, F. H. Walker. *West City*, vol. 7, no. 3, Mar. 1931, pp. 10–12, 5 figs. Lithia Park driveway improved at total cost of 66 cents per sq. yd., including catch basins and drains; method of construction; equipment used; estimated and actual cost.

PAVEMENTS, BRICK, CONSTRUCTION. Building a Modern Brick Boulevard near Cleveland, Ohio, H. P. Chapman. *Contractors and Engrs. Monthly*, vol. 22, no. 3, Mar. 1931, pp. 60–62, 7 figs. Report on construction of 8 miles of brick highway, 100 ft. wide, between Cleveland and Marietta; handling of aggregates; pouring base.

SEWERAGE AND SEWAGE DISPOSAL

CHLORINATION. Ammonia-Chlorine Reactions and Chlorine Production, L. H. Enslow. *Contract Rec.*, vol. 45, no. 10, Mar. 11, 1931, pp. 291–295, 3 figs. Discussion of lime-chlorine process in treating sewage; ammoniator installations in small water treatment plants; use of lime or chlorinated lime.

DISPOSAL PLANTS, FORT THOMAS, KY. English Type of Sewage Distributor on Kentucky Filter, C. H. Kuhn. *Pub. Works*, vol. 62, no. 3, Mar. 1931, pp. 24–25 and 72, 2 figs. Details of construction and operation of revolving device known as Adams Cresset Distributor, consisting of four-pipe arms perforated on one side and supported from vertical column by means of guy wires; reaction of sewage, as it discharges into bed in jets at right angles to arms, causes them to rotate.

DISPOSAL PLANTS, TOLEDO, OHIO. Separate Sludge-Digestion Plant at Toledo Mechanically Operated Throughout, H. P. Jones. *Eng. News-Rec.*, vol. 106, no. 10, Mar. 5, 1931, pp. 389–392, 5 figs. Description of world's largest mechanically operated separate sludge-digestion plant; sewage from east side delivered to plant through tunnel under river; mechanical equipment will provide for automatic cleaning of coarse screens, continuous cleaning of grit chambers, continuous sludge removal from sedimentation tanks, and mechanical agitation during sludge digestion; sewage to be prechlorinated to prevent odor formation; 3½-acre glass-covered drying beds will be located one mile away from plant; costs.

SLUDGE DIGESTION. Digestion of Raw Sludge Seeded with Ripe Sludge Filtrate, C. E. Keefer. *Pub. Works*, vol. 62, no. 3, Mar. 1931, pp. 29 and 72, 1 fig. Report on experimental work done at sewage disposal plant Baltimore, Md., for purpose of determining how quickly fresh sludge would digest when seeded with filtrates obtained from sludges in various stages of decomposition, and also to compare rates of digestion of these mixtures with same fresh material seeded with sludge proper; relative quantities of total gas produced from fresh sludge seeded with sludge filtrate and with sludge.

Influence of Seeding Material on Sludge Digestion. C. E. Keefer and H. Kratz, Jr. *Eng. News-Rec.*, vol. 106, no. 12, Mar. 19, 1931, pp. 474–478, 11 figs. Laboratory experiments at Baltimore indicate well digested sewage sludge of proper age not necessary for seeding purposes to obtain digestion when incubation temperatures are maintained close to 28 deg. cent.; characteristics of sludge used for seeding; grams of hydrated lime used to keep pH of sludge between 7 and 7.2.

The Effect of the Disposal of Water Softening Plant Sludge Through the Sewage Disposal Plant, E. F. Eldridge. *Mich. Eng. Experiment Station—Bul.*, no. 34, Jan. 1931, 7 pp., 1 fig. Objections to discharge of sludge from softening plants into streams from which water supply is taken; sewage sludge and lime sludge gas production; laboratory studies of effect of varying quantities of lime sludge on digestion of sewage solids show that there is a limit to percentage of lime sludge which can be mixed with sewage solids in sludge digestion tank.

UNITED STATES. Progress in the Treatment and Disposal of Human Wastes, R. E. McDonnell. *Mun. Sanitation*, vol. 2, no. 3, Mar. 1931, pp. 114–118, 3 figs. Sewage disposal by dilution; board of health activities; sanitation publications; Milwaukee's experiments; Pasadena's activated sludge plant; Los Angeles' reclamation experiments; growth in newer processes; separate sludge digestion; gas put to work; difficult financing hinders progress; sewage treatment plants as utilities.

STREET CLEANING AND REFUSE DISPOSAL

EUROPE. Observations on European Methods of Street Cleaning and Refuse Disposal, G. A. Soper. *Mun. Sanitation*, vol. 2, no. 3, Mar. 1931, pp. 127–128 and 131 3 figs. Excerpts from report on study trip, submitted to Committee of Twenty on Street and Outdoor Cleanliness of New York Academy of Medicine; Stuttgart Congress of Association of Superintendents of Municipal Vehicle Depots and Public Scavenging Work of Germany; machines which moisten, sweep, and pick up dust and dirt of streets as they move along.

STRUCTURAL ENGINEERING

COLUMNS, FORMULAS. The Strength of Compression Members, E. S. Andrews. *Structural Engr.*, vol. 9, no. 3, Mar. 1931, pp. 95–99, 1 fig. Comparison of formulas by Euler, Fidler, Moncrieff, Andrews, Johnson, and Rankine, with special reference to compression members made of mild steel.

WATER PIPE LINES

CONCRETE ENCASEMENT. Vibrated Concrete Coating Protects Underground Pipe Lines. *Concrete*, vol. 38, no. 3, Mar. 1931, pp. 23–24, 4 figs. Experiments conducted on large scale in laboratory of Portland Cement Association; vibrating practical and accurate way of placing concrete in thin reinforced layer around pipe; low water-cement ratio necessary; internal pressure test; materials required for applying 1-in. concrete encasement per mile of pipe line.

WATER TREATMENT

UNITED STATES. Softening a Well Water Supply, N. T. Veatch, Jr., and B. L. Ulrich. *Am. Water Works Assn.—Jl.*, vol. 23, no. 2, Feb. 1931, pp. 272–275. Description of process and equipment used in treatment of hard iron laden well water, at Manhattan, Kans.; operation of water-softening plant.

WATER WORKS ENGINEERING

CANADA. The Water Works System of the Border Cities. *Contract Rec.*, vol. 45, no. 10, Mar. 11, 1931, pp. 275–281, 5 figs. Details of pumping and filtration plants of Essex Border Utilities Commission and of distribution systems of Windsor and Walkerville, East Windsor Water Commissions, comprising 10 municipalities with total population of approximately 12,000 people; ice formation at intake; pumping equipment; mixing and coagulation basins; filter arrangement.

EUROPE. Observations of Water Supplies of London and Paris, E. Bartow. *Am. Water Works Assn.—Jl.*, vol. 23, no. 2, Feb. 1931, pp. 267–271, 1 fig. Southend Water Company; lime recovery plant; removal of tastes and odors by activated carbon; excess lime process of treatment; Kempton Park Plant, London; water plants at Ivry and St. Maur.

INTAKES. Water Works Intakes and the Screening of Water, J. W. Cunningham. *Am. Water Works Assn.—Jl.*, vol. 23, no. 2, Feb. 1931, pp. 258–266, 6 figs. Diversion of water from flowing streams; intake design; intake screens; sedimentation at intakes; fine screening of water.